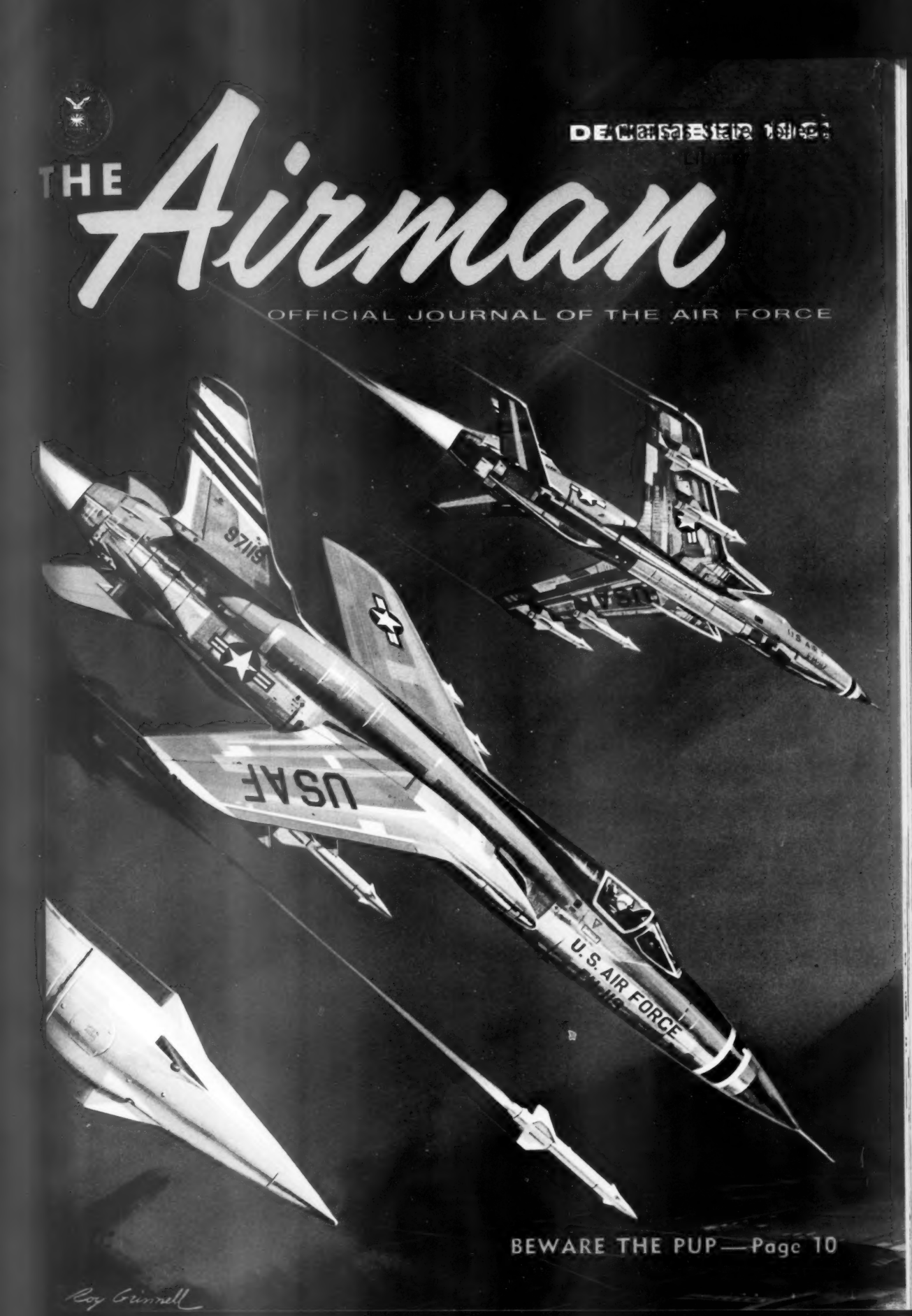
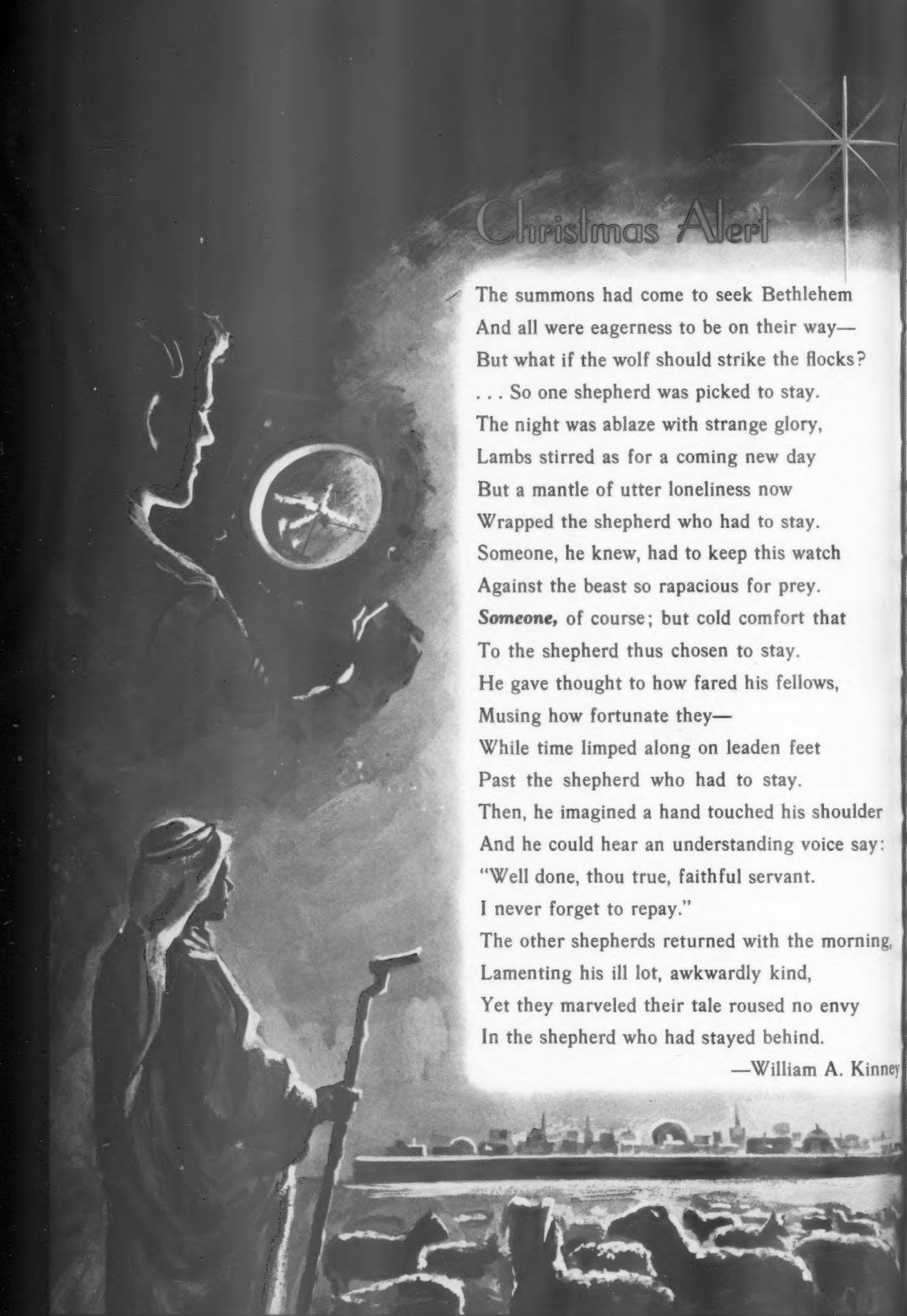

DECEMBER 1962
THE Airman
OFFICIAL JOURNAL OF THE AIR FORCE
USAF
U.S. AIR FORCE
BEWARE THE PUP — Page 10
Roy Grinnell



Christmas Alert

The summons had come to seek Bethlehem
And all were eagerness to be on their way—
But what if the wolf should strike the flocks?
. . . So one shepherd was picked to stay.
The night was ablaze with strange glory,
Lambs stirred as for a coming new day
But a mantle of utter loneliness now
Wrapped the shepherd who had to stay.
Someone, he knew, had to keep this watch
Against the beast so rapacious for prey.
Someone, of course; but cold comfort that
To the shepherd thus chosen to stay.
He gave thought to how fared his fellows,
Musing how fortunate they—
While time limped along on leaden feet
Past the shepherd who had to stay.
Then, he imagined a hand touched his shoulder
And he could hear an understanding voice say:
"Well done, thou true, faithful servant.
I never forget to repay."
The other shepherds returned with the morning,
Lamenting his ill lot, awkwardly kind,
Yet they marveled their tale roused no envy
In the shepherd who had stayed behind.

—William A. Kinney

THE Airman

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THE AIRMAN is primarily a medium for the exchange of ideas and information among Air Force personnel. Readers are encouraged to submit articles, short subjects, photographs, and artwork. All contributions will be given consideration; suggestions and criticisms are welcomed. Opinions expressed by individual contributors do not necessarily reflect the official viewpoint of the Department of the Air Force. All photographs are official USAF photos unless otherwise designated.

LETTERS TO THE EDITOR

CAP Comments

Sir: As a former cadet and now a senior member of the Civil Air Patrol, I was pleased and surprised to find General McElroy's summary of our activities and plans for the future in the July issue of THE AIRMAN. My morale went up a good 150 percent. I have been an avid reader of your magazine for more than three years and have always found it interesting and well written.

Joel Whitaker
Indianapolis, Ind.

★ ★ ★

Educational Benefits

Sir: I really enjoyed reading Lieutenant Shershun's article *Education —Passport to Tomorrow* in the September issue. I had never before really thought much about the rewards one can receive from education. However, the article opened my eyes, and I believe it has been the deciding factor in my decision to undertake extra studies. Keep up the good work.

A2C James A. Yelp
Maxwell AFB, Ala.

★ ★ ★

Congratulations

Sir: I wish to express my thanks and sincerely commend the staff for its recent article on Communism (*Communism and You,* September '61). It makes an excellent companion piece for Secretary McElroy's earlier article on the same subject (*Free World's Competition With Communism,* July '59). Too much cannot be done to educate everyone regarding the threat that Communism poses to the Free World. I sincerely hope that more and more detailed articles on this subject will be included in future issues of your fine magazine.

SSgt. Francis C. Beggan
Lockbourne AFB, Ohio

● *We have also featured articles by J. Edgar Hoover (February '60) and Charles Bohlen (February '61) on Communism. A second such article by Mr. Hoover is scheduled for the February issue.*

(Continued on page 36)

★ ★ ★

Cover design adapted from a painting by Roy Grinnell, courtesy of The Martin Company.

His place

By
LT. GEN. DEAN C. STROTHER
DCS Operations, Hq USAF

WHAT does the future hold for manned weapon systems?

What will become of aircraft and spacecraft pilots?

What can a human operator do to improve the effectiveness of our strategic warfare systems?

These and other similar questions are being pondered constantly by military planners. The answers add up to the simple fact that man, with his senses and intelligence, will be an integral and important operator of many of our vital weapon systems as far into the future as one can see.

The initial success of rocket boosters has caused many people to become fascinated with the so-called "push-button warfare." This belief that warfare can be conducted with vari-colored buttons from a remote refuge has tended to obscure man's role and what he can contribute to mission success by his presence at or near the scene of military action. As we become more familiar with the missile and some of its little-known limitations, more clearly do we recognize the fallacy of picturing man as a "pusher of buttons" rather than over enemy territory using his faculties to observe, report, analyze, decide, and initiate action based on the will to win.

For many years the United States has been a world leader because of its economic, political, and military strength. Although this position is being challenged constantly, the major objectives of our nation continue to be world peace and economic well-being. To achieve these objectives, we have adopted as one of our principal military objectives that which is most frequently referred to as "deterrence." In order to attain our national objectives and prevent the opponents of the Free World from making an overt bid for world domination, we must exhibit conclusive evidence of our determination and military ability to oppose any and all acts of aggression.

While most people agree with the policy of deter-

N AEROSPACE

he defense picture of today and tomorrow

Reprinted by permission of SPERRYSCOPE, Vol. 15, No. 9

rence, there is a tremendous difference of opinion as to how we can achieve it. We in the Air Force are convinced that the best method is to maintain capability to destroy the enemy's military force.

History has proved that wars do not follow a predictable pattern. Since we have adopted the policy of retaliation, this means that an enemy can start a conflict at a time and place of his own choice. To counteract this advantage and to preserve our own military strength, we must maintain a versatile offensive and defensive force with inherent flexibility to react to any situation.

Some Essentials

When we review the tasks which must be accomplished to insure that the United States will be victorious in any future armed conflict, we find our military force must be comprised of various weapon systems which possess certain essential characteristics. These characteristics are a high degree of survivability; short reaction time from launch to target; high accuracy of warhead delivery against all types of targets; and great selectivity of weapon effects. There is universal agreement in the Air Force that the characteristics of both manned and unmanned weapon systems will be necessary to achieve our national objectives.

I think it is important for everyone to understand that the military threat to the Free World is represented by missile sites, airfields, control centers, missile launching submarines, and enemy troop concentrations. The types of targets which must be destroyed to eliminate the military threat—minimizing damage to our nation—will vary from known and easily identified soft targets to hard and concealed or mobile target whose location may not be known. Our strategic offensive force must be capable of being used discriminately to seek out and destroy opposing military weapons and their support elements.

Continuing Requirements

Let us consider some of the specific and continuing requirements for manned aerospace systems.

First, the manned bomber is the best practical means available for destroying many significant military targets. If you will, visualize the targeting situation some years from now when the United States and its potential enemies possess large quantities of mobile missiles. Certainly, missiles cannot seek out and selectively destroy opposing mobile missiles. In addition, we can expect many of the important military targets to be concealed or at least inexactly located to such an extent that it impractical to use a missile against them. For example, soft targets whose location is known only within three to five miles may be destroyed with large high-yield missiles. But in the case of protected or hardened targets, this tolerance in location causes the probability of destruction to drop rapidly.

Potential targets vary greatly in size. Treating tar-

Manned aircraft can be launched at the first indication of attack. This is an easy decision to make, and weapon systems can adapt to whatever restraints are imposed.

gets as points for convenience in calculation is often misleading because it may result in the wrong choice of a weapon to be employed against a certain target. We must consider target complex diameter, type of construction to determine hardness, and expected delivery accuracy to determine the yield required to insure destruction. The point, of course, is that as the target complex becomes larger, higher yield weapons become increasingly desirable. While on the other hand as targets become harder, weapon delivery accuracy becomes more important. It is theoretically possible to use more than one of the smaller yield warheads to achieve the same result, but it is not always operationally practical.

Since we have no reason to destroy population centers as such, there is another category of targets for which missiles are not yet considered the best weapon because of their limited accuracy. These are the high-priority targets in or near cities. The destruction of these targets will require smaller yield weapons delivered with pinpoint accuracy.

Manned Aircraft Advantages

The manned aircraft is in many cases the most economical means of target destruction. Unfortunately, this is difficult to prove. But I am confident of the validity of the statement.

Major advantages provided by the manned system are multiple warhead delivery capability; recoverable and reusable features; and the inherent capability to be effective against all types of targets. Also of great importance is their value as a deterrent in a show of

force. This cannot be measured in a cost effectiveness study.

The recoverable feature of manned systems permits the demonstration of reliability and weapon delivery accuracy of each individual combat vehicle, not just the vehicle type. Our experience indicates that the probability of weapon delivery with an aircraft on its first flight is not very high; however, once the using tactical command operates the aircraft on a day-to-day basis, the reliability and weapon delivery accuracy are improved to the extent that they surpass the original specifications. In most instances, an air crew can either repair or compensate for an equipment breakdown and achieve complete or partial success for the original mission.

A manned aircraft has the quite familiar ability to be launched at the first indication of an attack on this country, and then be recalled if the warning proves false. This capability is a highly desirable one in today's environment where warning is not entirely dependable and a false start could trigger a holocaust no nation intended.

The "responsive mobility" feature of manned bombers, which helps survival in the event of a surprise attack, will become increasingly desirable near the end of this decade. The ideal situation, of course, is to keep aircraft on cocked alert at the end of the runway so they can take off immediately in response to the warning signal that an attack may be underway. This responsive mobility will be considerably less expensive than either the so-called continuous mobility of missile trains or submarines. To amplify, I would like to highlight a couple of factors about the advantages of manned aircraft when they are on ground alert.

First, the decision to launch an airplane is an easy one to make. The weapons are airborne and are not vulnerable to destruction on the ground, while the much more difficult decision to commit or recall the force is being discussed.

Second, we do not know the exact nature and kind of warning systems we will have after 1965, but we can be sure that the bigger the attack the better the chance of warning, hence greater bomber survival. Remember, under our policy of absorbing the first punch, our missiles may have to "ride out" the initial attack.

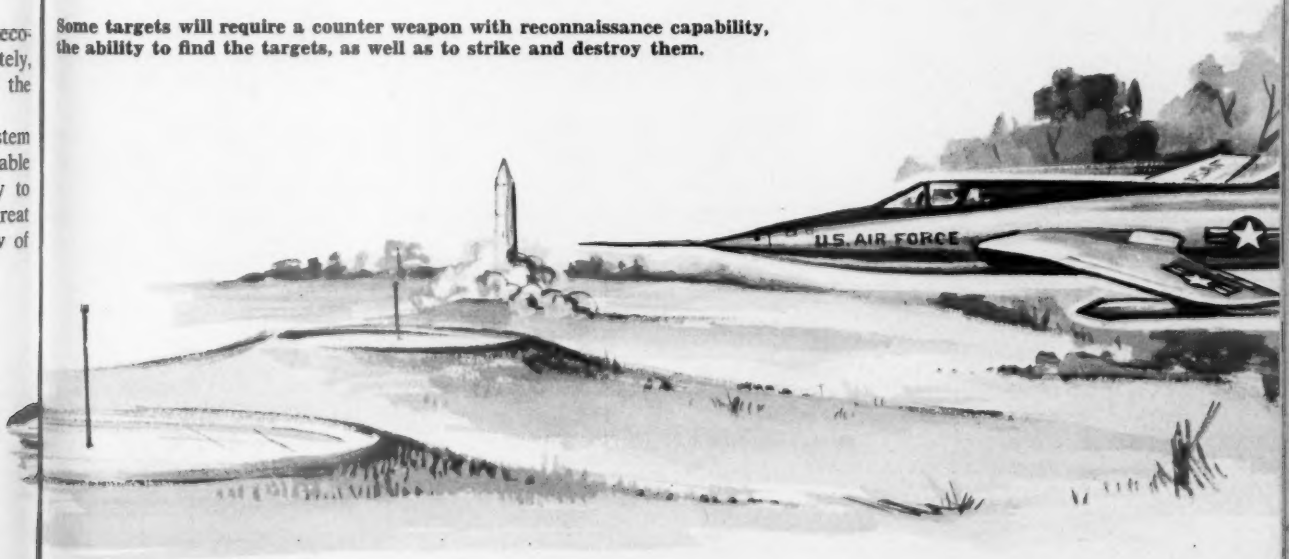
Mixed Force Needed

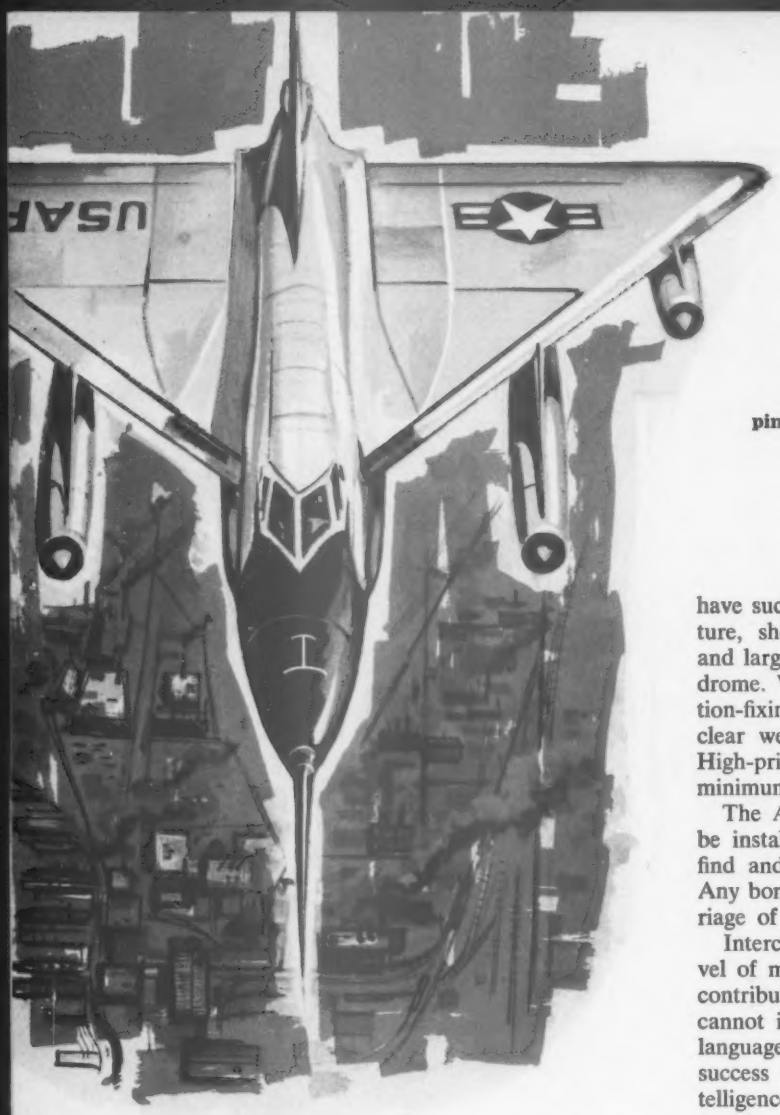
I want to emphasize that a mixed force of hardened missiles and bombers on ground alert interact to complicate the enemy's attack problem. If his attack is large, it can destroy many of our missiles, but it insures warning for the bombers. If his attack is small, he may destroy some bombers, but it will not do unacceptable damage to our hardened missiles. There are other considerations, but the ones given serve to illustrate the point that the mixed force is the most secure force.

Another important point in favor of the manned system is that purely military considerations are always subordinate to political ones. We cannot predict the future so we do not know what restraints political considerations will place on the military forces. This subordination of the military to political considerations is right and proper. Therefore, the military forces must be equipped with weapon systems with the flexibility to adapt to whatever restraints might be imposed. A pure missile force would not possess this flexibility. I do not intend to dwell on this point. It is mostly a question of exercising one's imagination about all the possibilities the future might hold and considering how each of them might influence the requirements imposed on our military forces.

There is a trend in military weapons that we are watching closely because it has some far-reaching implications as to what kind of capabilities are required

Some targets will require a counter weapon with reconnaissance capability, the ability to find the targets, as well as to strike and destroy them.





Missiles are not yet considered the best weapons for destruction of high-priority targets located near centers of population. Such targets require pinpoint delivery of weapons—by manned aircraft.

in the future. That is the trend toward making ICBMs mobile—on trains, on aircraft, on trucks, on ships, and on submarines. These mobile targets require a counter weapon with the ability to do reconnaissance —to find them—as well as to strike and destroy them. These two capabilities must be combined in the same vehicle because there is not time to wait between the find and the kill—the reconnaissance and the strike. For example, if the time lapse between spotting and killing exceeds 15 minutes, a 20-m.p.h. missile train can move beyond the lethal radius of a 5-megaton bomb.

We believe that the only reasonable and practical approach to achieving such a strike-reconnaissance capability is with a manned aircraft. It can provide the required versatile platform over the target.

Today we have radars undergoing flight test which have such high resolution that the radar scope, or picture, shows individual buildings, runways, taxiways, and large bomber or transport type aircraft on an airdrome. With this resolution for radar navigation position-fixing and target discrimination, small-yield nuclear weapons can be delivered with high accuracy. High-priority military targets can be attacked with minimum damage to any surrounding area.

The Air Force is evaluating equipment which must be installed in future bombers to insure that we can find and destroy inexactly located or mobile targets. Any bomber of the future will permit the optional carriage of multiple small-yield weapons.

Intercontinental ballistic missiles are certainly a marvel of man's technical achievement. They can and do contribute greatly to our deterrent posture. But we cannot ignore their inherent limitations. In aerospace language, the missile is inflexible. It does not report success or failure. It does not gather and return intelligence data. It is not recallable. Finally, there are certain targets which it cannot effectively and economically destroy.

Without degrading the missile and its necessary and rightful place in our arsenal of weapons, it is obvious that our technology has not reached the point where man and his intelligence can be replaced by black boxes. It is possible, in the ever-changing art of warfare, that rather than the missile replacing aircraft, it may be more likely that aerospace craft will replace the missile.

ICBMs cannot by themselves protect the United States and our allies. Nor can they alone assure a military victory. Unsupported by weapons of more versatile application, sole dependence on missiles could well invite the destruction of our own homeland.

Dispersed and mobile forces alert on the surface and in the air would assure a military victory. This guarantee of prompt and accurate retaliation is our insurance against foolhardy aggression by our potential enemies. Such insurance can only be bought with a well-balanced, well-mixed force including our best weapon systems, manned and unmanned alike.

ASTRONAUTS LOOKING FOR A JOB

Because the Air Force is a product of modern science, the hot pilots who chased the bugs out of yesterday's airplanes are giving way to pilot-engineers who will fly untried spacecraft past the wild blue yonder into the black beyond.

by CMSgt. EDISON T. BLAIR, Airman Staff

WHEN AN engineer's theory is first translated into tons of high-speed hardware, anything might happen—and fast. When the hardware is designed to operate in two mediums, both air and space, the already complex job of the test pilot becomes still more demanding. While under the stresses of test flying, the man at the controls must be able to think logically and clearly with a thorough knowledge of the theory.

"Future space systems will include a variety of hardware," Gen. Bernard A. Schriever, AFSC commander, told the Air Force Association in September. "As part of the flexible, mixed force we will need for the future, the manned vehicle is essential. Among the projected manned craft . . . (are) the true aerospace craft that will be capable of flight both within the atmosphere and out in space."

The Air Force has been firmly committed to manned space flight since the contract for *Dyno-Soar I* was signed and a test force was established. With the increased emphasis on space-oriented weapon systems and the space programs planned for the mid-sixties, test pilots must be ready for assignments to specific projects as early as possible in the development cycle. These pilots must not only be engineers; they must be specially trained engineers. The first group of these space research pilots started their advanced training at Edwards AFB, Calif., last June.

Unlike the pilots for the X-15, *Project Mercury,* and *Dyna-Soar* who were trained specifically for the job at hand, the graduates of the Space Research Pilot Course will form a pool of highly skilled pilot-engineers ready for duty in any future space program. They will combine the daring of the Wrights, Selfridge, and Doolittle with the scientific curiosity of Curtis, Northrop, and Goddard. Their job will be to determine the flight characteristics of still-to-be-built spacecraft and define the limits of its flight envelope.

"It's a long step from airplanes to space planes," Maj. Thomas U. McElmurry said. "Performance, for instance, will be much greater

The F-104 can be adapted to assume some of the characteristics of sophisticated vehicles students will later operate in space.

in aerospace craft. They will operate in two different environments; use different methods of control in each. Stability characteristics will be different. The research pilot will have to learn the vehicle's limitations in each environment.

"Research flight testing in space is a job for a man with all the qualities of the leather-jacketed, white-scarved, and begoggled pilot that flew the crates of 50 years ago. But he must have other qualities too. Like engineering knowledge."

Major McElmurry is Officer in Charge of the Space Research Pilot Course as well as the senior student in the first class. He and the other four members of the class are literally teaching themselves the fundamentals of space flight. Most of them will remain there as instructors. All are graduates of the old USAF Flight Test School, now known as the USAF Aerospace Research Pilot School. SRPC is essentially a postgraduate course in test piloting. The school will now have two branches, the SRPC and a more basic Experimental Test Pilot Course.

Older than his classmates, Major McElmurry had combat experience in both WW II and Korea. He was further seasoned by 18 months as chief test pilot checking out the *Sidewinder* air-to-air missile at high altitudes. He helped Maj. Richard C. Lathrop, former Flight Test School commander, develop the curriculum for the new course. McElmurry earned his mechanical engineering degree and a master's degree in aeronautical engineering between combat tours. As a civilian, he worked as a petroleum engineer.

All five members of the first SRPC class were experienced jet pilots long before they started test pilot training. Fifteen hundred hours of diversified flying experience was a prerequisite for the test pilot training. All had engineering degrees—most of them masters. Comparable backgrounds will be required of future SRPC students because they are preparing for the most difficult undertaking in the history of manned flight.

Wearing bright orange flying suits and tightly zippered flying boots, SRPC students have gone to the classes in the squat green building near the Edwards flight line since last June. They are working pilots as well as students and engineers, spending 30 or 40 hours a month flying precise practice test missions above the Mojave Desert. The course of study at SRPC is split between the classroom and the cockpit. Students study flight test techniques, then plan a test mission, fly it, collect data, reduce the data, and write a complete flight test report.

Major McElmurry still retains his native Arkansas friendliness and much of his lazy Ozark drawl. But there's nothing lazy about his thinking machinery. Ask him to explain roll coupling and he is likely to furnish you with 12 typed pages of step-by-step explanation liberally laced with explicit engineering jargon and advanced mathematical formulae complete with illustrating sketches. Like any test pilot, he leaves nothing to chance or the imagination.

"Our graduate must be an authority in every field related to his vehicle," he insists with the authority of the whole school staff. "Space flight is a step that must be carefully planned and executed right down to the last decimal point. It just can't be done by educated guesswork.

"The research space pilot will be a physicist, pilot, aerodynamicist, and engineer with a working knowledge of relativity, orbital mechanics, and propulsion systems. He will understand bioastronautics and astronomy. He will know how to collect data; how to use computers to reduce it; and how to communicate it clearly in engineering terms. He must be able to make a major contribution to existing knowledge."

That's why the academic side of the course lists such ponderous subjects as Newtonian mechanics—the laws of motion applied to bodies with normal acceleration—and Einstein's theory of relativity. Also listed under general theory are high-speed aerodynamics with its related theories to fluid mechanics, boundary layer theory, the dynamics and characteristics of rarefied gases, the laws of heat transfer, and thermodynamics.

Under applied theory comes atmospheric physics, astronomy, meteorology, orbital mechanics, propulsion systems, stability and control systems, vehicle performance, instrumentation, navigation, communications, and bioastronautics. The academic program is topped off with a liberal helping of computer fundamentals, both analog and digital, along with the mathematics needed to tie a research flight program into a meaningful collection of data and knowledge.

Of course, some of these subjects are started in the Experimental Test Pilot Course which will continue to be a prerequisite for SRPC. During the eight-month basic course the faculty carefully studies each student with an eye for his personal aptitudes as a space pilot. Only the top 15 or 20 percent, or about eight per year, will be selected for the advanced Space Research Pilot Course. Even then most of them will have to prove their abilities further by testing new weapon systems in the field before returning to school.

Thirty-three-year-old Frank Borman is among the first pilots trained for the space pilot's pool. Captain Borman walked off with top honors in the Flight Test School taking the Empire Award for academic pro-

ficiency and the Honts Award for overall excellence in his class. A member of the American Rocket Society who earned his master's degree at California Institute of Technology as an AFIT student, Borman is a former instructor in thermodynamics at his alma mater, the U. S. Military Academy.

Capt. Jim McDivitt, a test pilot formerly assigned to the 6512th Test Group at Edwards, is also a classmate of McElmurry and Borman. He, too, is an aeronautical engineer who graduated with honors from Test Pilot School. Before he came into the Air Force, McDivitt was a laboratory assistant for a large chemical manufacturer. He flew F-80s and F-86s in Korea and will probably become another member of the SRPC faculty with Major McElmurry.

The first four weeks of the space pilot's course is taken up with medical and physiological screening, bioastronautics, and pressure suit fitting and checkout. Another two weeks of the six-month course is reserved for seminars and field trips to system project offices, research and development test sites, and other areas of special interest. Also included are detailed briefings on earlier manned space flight programs. The remaining 18 weeks are divided between the academic and flying training portions of the course. An additional six weeks will be added to the third and succeeding classes. This time will be spent in simulator training and checkout training flights in an X-15 type of two-place aerospace trainer which is expected to be ready by then.

The flying program provides the students with added practical experience in planning and conducting a quantitative flight evaluation of a new machine. The aircraft used must be capable of performing and demonstrating many of the in-flight characteristics of spacecraft. School authorities believe that about 80 percent of the flying training in SRPC can be accomplished with aircraft presently available.

Two F-104s will be the workhorses of the space pilot's course for some years to come. An F-104 is the only aircraft now available that can be used to practice specific energy flight techniques—trade potential energy of altitude for the kinetic energy of speed and range as *Dyna-Soar* will do. Equipped with a drag 'chute and dive brakes, a "dirty" F-104 was used by X-15 pilots to practice for unpowered rocket plane landings. By varying the configuration—clean, speed brakes, or gear and flaps—the lift/drag ratio of the F-104 can be changed from approximately 2.0 to 5.0. This ratio closely resembles the flying characteristics of lifting reentry vehicles.

The supersonic F-104 can also maintain zero gravity for about one minute—long enough to learn what it feels like. The plane is so important to the training program that without it there would be no Space Research Pilots Course. The stubby winged fighter operates in the thin atmosphere where reaction controls are effective and function much as they would in a true space craft. One of the F-104s assigned to the school has been modified with reaction controls to indoctrinate the space pilot students.

The student spacemen will spend a lot of air time in the T-38 *Talon*, the Air Force's new supersonic training plane. But instead of learning to fly jets, these pilots will be gaining experience in planning and conducting stability and control investigations of the aircraft. They will practice test flying in other aircraft as well to further broaden their experience in evaluation techniques and procedures. When the X-15 space trainer is ready they will fly maximum altitude, range, and speed profiles just as Joe Walker, Maj. Bob White, and others have, to broaden their experience still more.

The simulator under construction and the training version of the X-15 will round out the remaining 20 percent of the flying training. The X-15 has all the attributes of a real space craft so far as training is concerned. It can fly an orbital arc. It requires a specific reentry profile, generates a great deal of reentry heat, and it uses reaction controls in a space environment. Pilots also become familiar with airdrop techniques and the complex support systems needed in space flight.

"All of this flying must be very, very precise," Major McElmurry said. "They are doing things in an airplane that they wouldn't learn in 20 years of normal flying experience."

Even before these pilots got their wings as fledglings they learned how to put a plane into a spin and recover. This was simply to learn how to recognize the attitude and what to do to get back to straight and level flight. But as research pilots they go well beyond this. They deliberately spin the aircraft and tape record the exact altitude and airspeed at the beginning and certain other predetermined stages of four or five turns. They tape record similar notes on recovery—what they did to start recovery, the plane's reaction to controls, the time and number of turns needed to recover, altitude lost, and any other detail that might be important in the operation of this particular aircraft. This is what Major McElmurry meant by precise flying.

Flying a performance evaluation and energy-management mission in an F-104 is even more precise. The student plans the flight profile and trajectory to get a specific combination of altitude, speed, and range. Sensitive accelerometers on all three axes of the plane record the aircraft's attitude throughout the whole maneuver. Other sensors measure and report the angle of attack. Meanwhile, Askania cameras and other space positioning instruments on the ground track the aircraft across the sky. Everything is recorded and the flight plan must be followed explicitly without the slightest deviation. The man who flies the mission reduces the data and writes his documented report.

The end result is a highly qualified pilot who already knows how to collect and reduce flight data in an aerospace craft not yet built.

The flight training emphasizes the need for absolute accuracy. Anything less is not acceptable. Because these men are going to step into an untried spacecraft and fly it beyond the wild blue into the unexplored black yonder. The nation and the future of our Aerospace Force may depend on how well they do the job.

BEWARE THE PUP

This supersonic air-to-surface missile, which can be launched miles from the tar

SHORTLY BEFORE DAWN an F-100 roars into the night from Nellis AFB, Nev. Two *Bullpups* (GAM-83) are tucked under its swept-back wings.

Minutes later it whines at high altitude as the pilot knifes through "enemy" defenses faster than the speed of sound. From thousands of feet above the terrain he spots the target—a supply train pulling out of a key railroad center.

The pilot rolls his *Super Sabre* in line with the target, enters a shallow dive and starts his missile run. Below, but still miles ahead anti-aircraft batteries prepare for his coming. They will wait in vain.

On target, he flips a toggle switch to select the missile and fires. With an angry growl, a GAM-83 streaks from the aircraft toward its mark. Watching two flares in the missile's tail, the pilot guides the missile to the target by working a control switch: *up, down, left* or *right*. He sends directional commands by radio, and control vanes on the missile change flight path as directed.

The pilot keeps the *Bullpup* zeroed in on the moving train. After pinpoint impact he pulls up his aircraft, climbs back to altitude for another run. Not once does he come within range of the antiaircraft batteries. After a second run the score reads: two passes, two direct hits; train destroyed, rail yard in flames. Training mission completed, pilot and plane head back to Nellis.

With GAM-83, you can almost thread needles from two or three miles away. It is only 11 feet long and weighs a puny 571 pounds. But mounted on pylons beneath the wings of a jet fighter-bomber it provides tactical air with a powerful bite.

A war baby conceived and designated *Bullpup* by the Navy during the Korean conflict, the GAM-83 traces its genealogy to the final days of World War II when the German Luftwaffe successfully used a guided bomb against allied shipping in the Mediterranean. *Bullpup's* development arose from three basic problems encountered during the Korean operations: the high attrition rate of pilots and aircraft forced to fly through intense ground fire on close support missions; extremely rugged terrain which precluded precise dive and glide bombing missions; and mismatch of free-fall bombs and unguided rockets with high-speed aircraft. The latter resulted in lowered strike effectiveness and required expenditure of large quantities of ammunition.

These factors underscored the need for a system to replace dive bombing. GAM-83 is that weapon system. The deadly accurate, solid propellant missile is now operational in some tactical units.

The man in the cockpit is still the most important component of the entire GAM-83 weapon system, because it doesn't really have a guidance system as missile-age airmen have come to understand the term. The pilot uses "eyeball tracking" and mental computing. He watches tracking flares in the aft end of the missile and uses the ingenious radio-link system to control its trajectory. In one test, a pilot hit a four-inch square target two miles away on his first try.

Although the sleek weapon performs with agility and precision, it is actually simple in design, construction, and operation. It requires relatively few components, is easy to assemble, and easy to launch and guide to the target.

GAM-83 has only three main sections. The aft section contains the solid propellant rocket motor or a pre-packaged liquid-fueled engine and tracking flares. The center section houses the warhead. The nose section contains guidance and control equipment. All three sections are easy to handle and assemble. It needs no preflight checkout; requires little test equipment.

Ease in handling makes the lethal package particularly suited to close support missions. The weapon is delivered ready for installation aboard an air-

ides a new punch for our tactical forces.

craft, an operation that takes only about five minutes using normal bomb loading equipment.

After extensive testing at the Air Force Systems Command's Eglin Gulf Test Range, the GAM-83A became operational in November 1960. Since then, pilots have been undergoing GAM-83 training at Nellis. Here at the "polish and perfection school" operated by the 4520th Combat Crew Training Wing, firstline fighter units from 12th Air Force acquire a new capability. On the vast Nevada desert gunnery range they rapidly learn the tactics and techniques necessary to become combat ready with the GAM-83. After five weeks of concentrated schooling on all phases of the weapon and its delivery, pilots return to their home stations to train their squadron personnel.

Before a flight at Nellis, pilots "fly" a realistic simulator. It duplicates the GAM-83's actual firing pass and the control movements required to score a bull's-eye. Students get to know the simulator well. They fly over 150 practice runs on all type approaches, against a variety of targets.

During his training and qualification period the pilot learns that he really has something new and different here. He discovers a flexibility not possible with conventional 20 mm. cannon, bombs, and rockets. He learns that he will be able to attack his target head-on, launch the missile, guide it to the target, pivot sharply in another direction and scoot like a rabbit so he won't be destroyed by his own holocaust.

"This bird's accuracy never ceases to amaze you," says Capt. Charles Myers of the USAF Fighter Weapons School. "Recently another officer and I made a trip to the target area to check markings on bull's-eyes. We were using spindly old range spotting towers for target centers. They had been hit repeatedly with a close, tight pattern of hits right on the money."

An advanced version, GAM-83B now under development, will deliver either conventional or nuclear warheads. The new GAM-83B has the added ability to "off-set" launch. This permits the pilot to fire the missile straight ahead and guide it to a target lying at extreme angles on either side of the attack direction. The pilot then directs the missile toward the target by radio control.

The Air Force has announced plans to add the deadly accurate GAM-83 to the F-105 *Thunderchief* which can fly at twice the speed of sound, operate at altitudes above 50,000 feet. Mating the Mach 2 fighter-bomber to the highly respected GAM-83 will greatly increase the TAC strike capability and make a significant addition to our tactical support force arsenal.

An outstanding feature of the GAM-83 is the ease with which it can be handled by ground crew personnel. The missile is stored in three sections. A three-man crew can clip it together and load it on the aircraft in fewer than five minutes, ready for action without any further preflight checkout.

NO PLACE TO LAND

Often only the courage and professional skills of Air Force crewmen stand between a close call and disas

by Capt

TWO ENGINES WERE ALREADY TURNING OVER when I stepped from the icy loading platform into the C-54. Handcuffed to my left wrist was a brown leather briefcase bulging with more than fifty thousand dollars in crisp, new fives, tens, and twenties.

Under my parka was a fully loaded .45 caliber automatic. Its obvious bulge and questionable readiness didn't impress anybody, particularly me. If somebody did try to steal the money, where would he go with it? The flight would depart Goose Bay, Labrador, traverse 800 miles of barren, Arctic wasteland, to terminate at Frobisher Bay, hand-carved air station at the southern tip of Baffin Island.

I strapped myself in the seat and glanced at some of the fellow passengers with whom I would spend the next four hours. There were three civilians (construction people from the looks of their clothes), seven young airmen, obviously new to the Arctic and the U. S. Air Force, and one other officer, a lieutenant on his way back to the radar site situated on a high mountain overlooking the base at Frobisher. He was returning from leave. He didn't know it, but his pay was in my briefcase, along with the payroll for several hundred other Air Force personnel at Frobisher. They wouldn't find out until 24 harrowing hours from now just how close they came to missing their payday!

As the airplane gained altitude we felt the first welcome breath from the heaters, the warm air boosting the minus 25 degree cold to a point just above frostbite. The weather, forecast clear en route and at destination, deceitfully promised a routine flight. The aircraft belonged to the Arctic-wise transport group stationed at Torbay in Newfoundland. For several years the crews had flown a regular schedule throughout the Arctic—Goose Bay, Narsarssuak, Sondrestrom, and Thule. They had run special flights across the Arctic Ocean to floating ice islands, plumbed the mysteries of Pearyland and supplied the sites of Dew line throughout the Northwest Territories. The crews knew their business and my confidence in them never wavered; not even later, when we thought our only remaining alternatives were attempting a crash landing or bailing out in Northern Labrador. But now things were tranquil, and we alternately chatted, read, and looked at the barren scenery unfolding below.

Whiteout!

No novice to Arctic flying myself, I had spent two years in Alaska, and a year in the northeast as a navigator and a radar observer. That is probably why I sensed trouble when we were about one hour out from Frobisher. The clear weather had gradually grown murky, and from 10,000 feet I could barely make out the jagged, snow-covered peaks below. Soon we were in the soup—the Arctic kind of soup called a "whiteout" which can terrify the most steel-nerved, cool-eyed veteran of northern flying. It looked—as an imaginative pilot once said—like the inside of a ping-pong ball. The lieutenant and I exchanged glances. The construction men, who apparently had been here before, were visibly nervous. Only the young airmen were unperturbed and I envied them their ignorance for it was truly bliss.

That last hour seemed longer than the first three. We checked our watches every few minutes, waiting for the soup to clear before the ETA painfully crept up. But the weather only got worse. Then the engines were throttled back and I felt the loss of altitude, banking gently through the white nothingness. We were letting down for the approach and landing. I knew we were on Frobisher's radar scopes, that the pilot was letting down under Ground Controlled Approach (GCA). I also knew there were deadly peaks around the base, that radio and radar is sometimes unreliable this far north. For my own peace of mind, I knew too much. I strained to see the ground, the breakout that would mean we could touch down. They must have a ceiling I thought. You can't even attempt a landing here unless the ceiling is above 500 feet and visibility is at least a mile. I saw nothing but whiteness. Suddenly the

by Capt. TED R. STURM, USAF (Ret.)

engines roared and the plane lurched forward, picking up speed. Go-around! We had reached minimum altitude and had not seen the ground. Bore straight ahead and climb! Pray to God that those man-made electronic devices are working right, that the calm-voiced controller has given you a course that is true; that in the next instant you, your companions, one each C-54, and $50,000 in U. S. currency will not disintegrate against a rocky peak!

We climbed steadily and the engines settled back into a relieved, even drone. We banked again. Another try. No luck. Three more soul-searching tries, each second an hour long. I pitied the pilot and crew. I knew they must be exhausted. On the last try the engines roared our failure, pulling us up, up, giving us the blessed sanctuary of altitude. My ears popped as we passed through 10,000 feet, far above the peaks. I sensed the turn that put us on a heading back to Goose Bay. It was no use. We couldn't get in today; perhaps tomorrow.

We had now been airborne five hours, and the light was fading rapidly even though it was only 3 p.m. A few miles out of Frobisher we broke into the clear. The lieutenant walked over and sat next to me.

"That was hairy," he said with a grin, and I nodded. He leaned closer so he wouldn't have to shout so loudly over the engines. "I can use another night back at the Goose," he went on. "I'm not the least bit anxious to get back to Frobisher."

"I guess not," I answered, "but I wish we'd gotten in. I've got their—and your—payroll here, and it's a lot of rigamarole checking it in and out again."

"I know. I've been paying officer myself." He glanced out the window at the snowy white terrain that penetrated the darkness below, and at the stars which were now visible. "Looks like clear sailing back to Goose."

"We can use it," I said, never dreaming that what we had just been through at Frobisher was routine compared to what was to come.

An Icy Trap

I got the first inkling when the navigator, a boyish-looking first lieutenant, left the crew compartment and went back to the rest room. He shook his head as he came by me and I motioned for him to stop by.

"How's it going?"

"This just isn't our day," he said. "Ground fog has rolled over Goose and it's closed."

"Great! So where do we go now?"

"I wish I knew, captain. The whole cussed Arctic is brewing up polar-bear weather. We're checking around for a place to roost now." As he moved off, he said he would let me know.

The passengers were all asleep or reading so I pondered the problems we faced. We had now been airborne for seven hours and the range of the C-54 was normally about 10 or 12 hours. We were still two hours out of Goose, but Goose was closed. Farther South was Torbay, a three-hour trip from Goose. Three plus two makes five. Add that to seven and you get 12 hours. Too far and too close.

How about Sondrestrom, Greenland? Farther yet.

The facts spoke for themselves. There was no base within our remaining fuel range. The Arctic was closing its icy trap and we were in its jaws.

It seemed logical to me that our only alternative was to continue to Goose Bay, either attempt to come in totally blind, orbit in hope that the fog might clear, or then, when our fuel was exhausted, bail out over or near the base. There, chances would be good that we'd be picked up before we froze to death. Unless, of course, some of us were unfortunate enough to come down in the frozen slush and ice of Hamilton Inlet. That's why I was shocked to the tips of my chilled toes when the airplane went into a steep bank, made a complete 180-degree turn and headed back toward the lifeless, frozen Arctic!

Passengers normally are not allowed in the crew compartment, but things were anything but normal. Heading for the door, I noticed that every passenger

on the aircraft was wide awake. The civilians looked unbelievingly at the spiraling stars, stared incredulously as the aurora borealis moved slowly from behind to ahead of the C-54. The young airmen were simply puzzled, apprehension corroding the veneer of derring-do they had worm through the first part of the flight.

The crew compartment was a study in controlled frenzy. The navigator drew course lines on his charts, checking every few seconds with the radar operator. A staff sergeant hunched over radio dials, speaking calmly but earnestly into a small hand mike. The crew chief, a tech sergeant, checked fuel gauges, computed consumption, balanced them against the Estimated Time of Arrival. But arrival where?

A Tiny Strip

The pilot appeared unconcerned about the situation. He puffed a cigarette, watching the rushing slipstream suck the smoke out of the cockpit. The copilot was flying the plane. I picked up a headset and listened in.

"Air Force 889, this is Flashlight. We're painting you okay. We've still got a broken ceiling and 10-mile visibility, but it looks like it could close anytime."

Flashlight! Surely we were not going to try to land at Flashlight! This was the code name for an isolated radar station situated on a high bluff overlooking the Labrador Sea. It was near a little Eskimo village called Saglek, but what was so astonishing were a few facts about Flashlight that didn't add up to landing a C-54 there at night.

First, the runway was gravel, designed to accommodate the smaller C-47. No four-engine aircraft had ever landed there.

Second, the runway was pitched at about 20 degrees, which meant we would be forced to land uphill.

Third, if the airplane landed long, there was a drop of several hundred feet over the sheer face of a cliff to the sea below.

Fourth, there was absolutely no runway lighting.

And fifth, to approach the strip it would be necessary to maneuver the big 54 in a steep left turn over a bay surrounded on three sides by craggy mountains pinnacled well above our approach altitude. Then the pilot would have to crank the airplane back level in the last instant before hitting the low end of the strip which also began not too many feet from a rocky cliff.

If we were only a few feet too low, we'd hit the cliff. Off either to the right or left and we would hit a mountain. Too high, and we could overshoot the runway—if, indeed we could even see it without lights!

The pilot saw me and beckoned me forward.

"We're going to try for Saglek," he said. "It will be close. This tired crate burns gas like a Grand Prix winner, so it was too risky to even try for Goose."

I nodded. "That's what I figured. But how about the weather, the runway, the lights, and a few other items?"

He shrugged. "You might pray with us," was his suggestion. I knew he was only half kidding.

I returned to the passenger compartment and was immediately deluged by questions from my now thoroughly concerned companions. I told them all I knew, and each man leaned back with his private thoughts. Personally, I took the pilot's suggestion. Tight spots are no novelty to people who fly regularly, but each time I got in a jam I mentally reviewed the chain of events which led me there. I never cease to marvel at the circumstances over which people have no control; the fate that places them at a certain place at a certain time to find that death is lurking nearby. The solace to be gained from a fatalistic outlook when in the safety of one's living room dissipates with remarkable rapidity in periods of danger. "When it's your time to go, you'll go," the believers of the preordained claim. The plaguing question at 10,000 feet over the Arctic with no place to land inevitably evolves to: "Is this your time?"

More was out of the crew's hands than was in them. They had the skill, ability, and plain guts to do everything right. But would the weather hold? Would we get a few more minutes from the fuel than we expected? Would the indispensable radar that guided us to our haven continue to work properly? Would a sudden side gust, or updraft on landing throw the aircraft off for just one fatal second? Was this *the* time? Only God knew, and there were no atheists aboard Air Force 889 that night.

Light! But From Where?

There was nothing to do but wait. Slowly we descended through a now solid undercast. It looked like our luck had run out. Apparently the weather had closed in at Saglek. "We," I thought to myself, "have had it."

Then briefly, we caught sight of the ice below. We were over the sea and the clouds were now broken. The C-54 groaned as the pilot put it into a hard left turn. Now I could see the radar station and below it, to my amazement, barely discernible flickers of light marking the landing strip. How had they managed that?

On the left the ominous peaks were close enough to touch. It seemed that we were too low, that the cliff ahead on top of which the strip extended was higher than we. But no, we were rounding out now, "on the beam" I thought tritely.

Suddenly we were lifted skyward for what seemed to be a hundred feet. Updraft from the cliff! In my mind's eye I could see the pilot fighting for control. He must be superhuman! Relentlessly he forced the nose down.

We were over land now. The 54 rocked for a brief instant and we were down! A spontaneous cheer burst from the passengers, and as far as I know, the crew as well. We taxied toward a waving flashlight and I stepped out to the most amazing sight of my career.

The hundred men of the Flashlight radar site were lining both sides of the runway. They held cigarette lighters, improvised torches, flashlights, and lanterns. Their jeeps and trucks were there, too, headlights blazing. This was how we got our runway lighting. I was humbled, for I knew only too well that they had risked their lives for us. One cross wind, a blown tire on the rough runway, any one of a dozen possibilities could have sent our airplane along those lines of human beings like a reaper in a field of wheat.

As we stood talking to the site commander, I suddenly realized that I had completely forgotten the briefcase and money latched to my wrist. Later, I put it in his safe and joined the crew, the station commander and his staff, and the passengers in the mess hall.

Early the next morning we took off. The brief moments of concern when the airplane barely broke ground as we ran out of runway were insignificant to the events of the night before. Besides, I was still remembering the crew chief's answer when I asked him after breakfast just how much gasoline we had left when we landed.

He looked at me and smiled. "About 20 minutes worth, captain."

"There's a long, lon ail

THE FAMILIAR STRAIN OF THE OLD WW I TUNE is a befitting background for the strange but true events which had their beginning in the early spring of the year 1918.

The dying year of the great "war to end all wars" ushered in stepped-up activity all along the western front.

The German High Command taking inventory of its manpower reserves discovered that they were practically exhausted. A "shoot the works" push across the Marne, through Paris—and on to the channel ports to prevent further debarkation of the fresh troops from America—was a must.

Back on New York's Fifth Avenue, another scene was being enacted—seemingly unimportant—a scene which would reach its climax over the Toul sector and apparently end somewhere in the skies over Chateau Thierry.

A well-constructed young man in his early twenties made a hurried and rather unorthodox purchase, so far as the hallowed halls of Abercrombie and Fitch, Fifth Avenue were concerned. They condoned the hasty transaction because this was a young man in a hurry—to catch a troop transport to France.

Lt. Fred W. Norton, former Ohio State football star, now a member of the infantile but elite U. S. Air Service, had just purchased a fine leather jacket, a garment designed and tailored exclusively for a new breed of fighting man—the aviator.

Lieutenant Norton hailed a cab, shouted the number of a Hoboken pier to the cabbie and was off on the first leg of a journey into eternity.

Upon his arrival in France, Fred Norton was assigned to the 27th Aero Squadron, a crack pursuit outfit operating with Eddie Rickenbacker's 94th Pursuit squadron as a part of the First Pursuit Group.

General Billy Mitchell, Commander of the First Air Brigade, which included the First Pursuit, was slowly succeeding in getting his fighter pilots out of the cockpits of the old French, fabric-stripping *Nieuports* and into the newer, faster, and sturdier Spads.

On July 2, 1918, Mitchell's task was just about accomplished and the 27th Squadron was ready to put up one of its first "massed" patrols against the veteran Baron Von Richtofen "Jagdstaffeln" which was manned by some of Germany's finest aces flying the fast and respected *Fokker* airplane.

Lieutenant Norton was leading one of those patrols —a patrol of eight airplanes from the same squadron which would produce the famous American Aces Frank Luke, Joe Wehner, Jerry Vasconcelles, Hank Hartney, and Donald Hudson.

The patrol hurried down the grass field, lifted off into the gray dawn and were soon poking their wooden props through the clouds over "no-man's land."

The Americans' sight-seeing tour was soon terminated as, with very little warning, nine of the Baron's finest *Fokkers* came barreling out of the sun and confidently bounced the Johnny-come-lately Yanks.

Fred Norton wasn't caught napping. His head was on a swivel. At the first glint of the red-nosed Jerries, Fred tightened up his flock and turned into the enemy gaggle. Right smack in Norton's gun sight was framed one of the sleekest looking machines he had ever seen. His decision was not delayed. He triggered his Lewis guns, and after a few bursts wished that he had brought along a sling shot. Both guns were hopelessly jammed.

Let the records of the official Army Archives give a more accurate account of that air battle.

" . . . Fred W. Norton, First Lieutenant, 27th Aero Squadron, is awarded the Distinguished Service Cross for extraordinary heroism in the Toul Sector, France. On July 2, 1918, Lieutenant Norton, a Flight Commander, led a patrol of eight machines, the first large American formation to encounter a large German Patrol. His command gave battle to nine enemy battle planes driven by some of the leading aces of the Ger-

...ail a windin'..."

by Maj. PHILIP D. RIBLET, Jr., USAF
Sandia Base, N. Mex.

man army. Although both of his guns jammed at the beginning of the fight and were therefore useless, he stayed with the formation, skillfully maneuvering his machine to the best advantage. He was attacked by enemy airplanes at four different times, but skillfully avoided them or dived *at* them. His continued presence was a great moral help to his comrades, who destroyed two of the enemy planes . . . "

Exactly three weeks later, on July 23, 1918, Lt. Fred W. Norton was dead.

On July 20th, somewhere over the Chateau Thierry sector, Fred Norton was mortally wounded by two German machine gun bullets which failed to knock him out of the sky. With the same grim determination displayed on the gridiron he stayed with the formation until the end of the fight and then somehow managed to coax his bullet-riddled crate back over the lines. He was rushed to a French hospital where he died, probably without ever knowing or expecting he would be awarded his country's second highest decoration.

The Armistice was signed. The bands, joy, and shouting died down. People turned their thoughts to the more important things on the home front—the Eighteenth Amendment, the child star Jackie Coogan, railroad strikes, and bobbed hair. Back in Columbus, Ohio, at 127 West First St., the Express Company delivered a large box.

Mrs. Catherine Norton, to whom the box was addressed, could not bear the pain of opening it. It was plainly marked, "Personal effects, Lt. Fred W. Norton." She left it on the front porch for a few days and then gave the box and its contents to her friend and neighbor, a Columbus painting contractor, Mr. U. C. Urton.

About 10 years later, Mr. Urton, with his young son, Bud, was rummaging through the box looking at war souvenirs, when they came upon a fine leather jacket lying at the bottom of the container.

Closer inspection of the jacket revealed that parts of the garment were stained and stiffened from dried blood which originated from two bullet holes, one in the back of the coat and one in the right sleeve. A search of the pockets produced two French hospital tags which identified the owner as Fred W. Norton, First Lieutenant, First Air Brigade, AEF. It was then that Mr. Urton realized that this was the jacket which Fred Norton was wearing when the two German slugs ripped into him and started the flow of blood which eventually claimed his life.

Young Bud Urton inherited the jacket, along with other family heirlooms. Bud Urton grew up to be a top

The long, long trail nears its end as Maj. Gen. Harold C. Donnelly accepts jacket on behalf of the Air Force.

patrolman with the Highway Patrol, State of Ohio. His subsequent travels took him far and wide. He finally settled down in Albuquerque, N. Mex., after joining the security staff of the Atomic Energy Commission. He brought Fred Norton's flying jacket with him.

In May 1961, realizing the historical value of the war relic, Mr. Urton inquired if the Air Force would be interested in the jacket as a museum piece.

Maj. Gen. Harold C. Donnelly, USAF, Commander, Field Command, Defense Atomic Support Agency at Sandia Base, was informed of the availability of the jacket and he directed Maj. Braxton Allran, Air Force Personnel Director for Field Command, to make the necessary arrangements for the Air Force acceptance.

Mr. John W. Gross, Director of the Army Branch, Military Personnel Records Center in St. Louis, Mo., forwarded authenticated records of Lieutenant Norton's deeds to Sandia Base, N. Mex., and Maj. Robert L. Bryant, Director of the Air Force Museum, Air University, Wright-Patterson Air Force Base, Ohio, informed Field Command, DASA, that the museum would gladly accept the jacket and hospital tags as a permanent exhibit.

On July 21, 1961, at ceremonies appropriate to the occasion, General Donnelly, on behalf of the Secretary of the Air Force, accepted the gift from Mr. Bud Urton.

The long, long trail which began 43 years ago in a New York show window finally came to an end at the Air Force Museum—and fittingly so—in Ohio the birthplace of aviation.

The flying jacket of Lt. Fred W. Norton, pioneer fighter pilot, star athlete and hero, has found its final resting place.

THE RELUCTANT EXHIBITIONIST

by Capt. GEORGE W. OGLES
Hq. 6146th Air Force Advisory Group

"Having no recourse, I just dangled there . . ."

IN THE EARLY 1930s student riggers of the Air Corps were required to pack a parachute and actually test it personally in order to complete their course of training. Startling as this requirement may seem today, it was considered a routine matter by the daredevils who then comprised the still wild and wooly air arm. Routine, that is until a young student made his graduation jump from the open cockpit of a Douglas 0-25.

Now, 30 years older, and much wiser, SSgt. Harold Osborn of Bergstrom AFB, Tex., tells of his first (and only) parachute jump and still gets a mild chill. Not even his later exploits as a mechanic with the famed Flying Tigers rival the excitement and tension of the 45 minutes he was towed about the Illinois sky, hanging helplessly from the horizontal stabilizer of the 0-25.

The Osborn of 1931 was a raw-boned, curious young man eager for three meals a day, a steady salary and the chance to learn a skill. The Army Air Corps of the early depression days promised to fill the bill. Although it lacked funds, good equipment and Congressional backing, it didn't lack fervor in its struggles for recognition. Young enlisted men like Osborn and officers like Lieutenants Curtis LeMay and Roger Ramey of the Selfridge pursuit squadron held the Corps together with tenacious courage and faith in the future of airpower.

Osborn was first a mechanic, and his association with aircraft aroused his curiosity about parachutes. Soon he was on his way to Chanute Field, Ill., to attend the Air Corps Parachute Riggers School.

June 5, 1931, dawned clear and pleasantly warm. Private Osborn and his 10 classmates greeted the day with the mixed emotions of youthful enthusiasm and mature caution. After six weeks of classroom instruction in parachute rigging, the day had arrived for the final test of their talent and courage.

Master Sergeant Nichols, the senior instructor who gave the pre-jump briefing, was recognized as one of the best parachute men of his day—a reputation supported by 14 patents on parachutes. His knowledge of parachutes and feeling of personal responsibility for the well-being of each student won the deepest respect of his pupils who followed his instructions to the letter. He concluded the briefing by directing the fledglings to pull the rip cord immediately upon jumping from the Ford tri-motor transport plane. Nichols believed a jumper might become unconscious during a free fall.

At the last minute the transport plane developed a gas leak and was replaced by a number of open-cockpit Douglas 0-25 and 0-19 observation planes. Unfortunately no new jump instructions were given Osborn and his classmates. As a result, the spectators were treated to an exciting demonstration of uncoordinated exits from open cockpits, climaxed by the grand finale of Private Osborn's unique performance.

"The pilot circled a graveyard before my jump," recounts Sergeant Osborn. "He thought it would be humorous. At 2,000 feet I got out of the cockpit, balanced with one hand and held the rip cord with the other. The pilot banked the plane and I jumped, pulling the rip cord at the same time as instructed.

"Unlike the previous jumpers, my parachute did not bounce off the tail section and open, but became entangled on the horizontal stabilizer and held fast.

"I was completely shocked at first. My next thought was that I hadn't packed the 'chute properly. Having no recourse, I just dangled there as my pilot circled the base wondering what to do.

"Below I could see excitement and anxiety in the crowd. Someone sent a meat wagon that chased around

After his first and last jump, Osborn posed for this photograph, with the memory of his experience etched in his face.

attempting to follow the plane. Some enterprising publicist contacted the newspapers and before long four or five thousand persons had assembled to watch me dangle."

Osborn had a 22-foot chest pack but it was connected to the harness of the 28-foot training 'chute which clung to the aircraft. Since the early parachutes had no release buckles, he could not release himself from the tangled parachute to use his chest 'chute.

After Osborn had been dragged through the sky for about 40 minutes, the pilot flew to Lake Decatur, about 40 miles from Chanute, intending to let Osborn slip out of his harness and drop into the lake.

"I was certain this plan would never work," emphasized Osborn. "Even if I had missed one of the many boats in the lake, hitting the water at 90 miles an hour would have been like jumping from a 10-story building."

On the way to Lake Decatur another plan was tried. A jackknife was placed in a shot bag and lowered from the rear cockpit of another plane. Osborn grasped the bag, removed the jackknife and quickly cut the harness which held him prisoner. Dropping free he tore at the auxiliary pack which had no pilot 'chute and unceremoniously pulled the silk into the void about him. Watching the canopy blossom above him, Osborn sighed in relief.

"I came down in a cornfield about 20 miles from Chanute and hit pretty hard. Needless to say, I was happy to be on the ground—in one piece. My pilot landed in a nearby meadow. He gave me his 'chute and we flew back to Chanute."

As a result of Osborn's parachute experience, knives were placed in all succeeding parachute packs. The conscientious instructor, Sergeant Nichols, died of a heart attack before he could graduate another class.

Osborn, a weaker but wiser man, returned to his old job as an aircraft mechanic with the pursuit squadron at Selfridge.

During the next 30 years he was in and out of the service three times. Today he is a flight simulator instructor with the 4130th Operations Squadron at Bergstrom AFB.

PARACHUTES WERE OLD HAT IN ANCIENT CHINA

A growing number of people are jumping—from great heights—for joy these days.

They are parachutists who leap for sport. The pastime has now become so popular that Najeeb E. Halaby, administrator of Federal Aviation Agency, recently made his first parachute jump to acquaint himself with skydiving problems.

Mr. Halaby followed the first recorded parachute jumper by some 4,000 years, the National Geographic Society says. The first parachutist apparently was the Chinese Emperor Shun, who lived about 2200 B. C.

Se-ma Ts'ien, a usually reliable Chinese historian, wrote that Shun's evil father made his son climb to the top of a granary, then set fire to it. Young Shun held up two large, circular reed hats, sprang from the tower, and floated gently to the ground—so the story goes.

Leonardo da Vinci hit upon the theory of parachutes early in the 16th century. Leonardo sketched a device shaped like a four-sided tent and noted that a man using it "would be able to let himself fall from any great height without danger."

Later experimenters adapted the parasol as a braking device for leaps. A French physician, Sebastien Lenormand, jumped from a treetop in 1783, holding two parasols.

In 1785, Jean-Pierre Blanchard released from a balloon a silk parachute which carried a dog safely to the ground. The demonstration inspired a British sailor named Appleby to attempt a drop from S. A. Arnold's balloon, the "Royal George." The trip was a near-tragic comedy of errors.

Wind dragged the balloon car, and Appleby was wrenched off by a fence. The gondola then hit a cart, pitching out Arnold and the sand ballast. The lightened balloon bounded upward with Arnold's son the only passenger.

The wild up-run caused the gas to expand so quickly that the balloon burst. The gas bag, however, collapsed into the surrounding net of ropes and served as a parachute. Young Arnold was wafted into the Thames, none the worse for his ride.

Andre-Jaques Garnerin, a French aeronaut, opened the era of modern parachuting in 1797 when he leaped 2,000 feet from a balloon over Paris. Garnerin's parachute swayed so violently it made him airsick. He later reduced the oscillation by cutting a hole in the top of the parachute canopy which allowed a steadying stream of air to escape. Present-day parachutes use a similar vent.

With the invention of the airplane, arguments arose whether man could survive bailing out at the "terrific speed" of 30 miles an hour. One of the first to parachute from an airplane was Grant Morton, who leaped at Venice, Calif., in 1911. He carried the canopy of his 'chute under his arm and threw it out after he left the plane.

World War I speeded development of the parachute. By 1919, the United States Army had devised the familiar seat-pack parachute. World War II helped create paratroopers, parachutes suitable for bailing out of high-speed planes, giant cargo 'chutes, and other innovations.

Sports parachutists have developed extremely maneuverable parachutes. They are interested in style and accuracy in drops, and not mere numbers.

EVER BEEN STATIONED AT SHEPPARD AFB? UNLESS YOU WERE RECENTLY, YOU MAY AS WELL SKIP THIS ARTICLE. YOU'LL NEVER BELIEVE IT.

WHAT'S HAPPENED AT WICHITA FALLS

by 1st Lt. CARROLL SHERSHUN,
Airman Staff

WEARING CIVVIES, I got off the airliner at Wichita Falls' new municipal airport located on the southeast corner of Sheppard AFB. To Bill Lee, the middle-aged Texan with whom I shared a cab, I was just another civilian. Bill had apparently lived in Wichita Falls for a long time. That's what made his remarks so enlightening.

"They've got a fine bunch of young men out there," he was saying. "We're real proud of our base." He didn't know it, but he was volunteering information I had come to gather. Sheppard was reputed to have a unique and highly successful community relations program. If it measured up to its claims, it would make a good story—maybe even serve as an example for other bases and communities.

Bill was continuing. "But I can remember several years ago when the base commander put the whole town off limits."

"Why was that?" I asked.

"We resented the airmen when they first came. Texans are pretty hospitable, I guess you know, but things were pretty bad in those early days. We weren't too happy about the changes it meant in our way of life. The kids were especially unhappy about having to compete with airmen for their girls and for a while it got real bad. Knife slashings, tire chain whippings, gang fights, the works."

I recalled among the first words I heard during my basic training days at Sampson AFB back in 1951 the tales former Sheppard-men told about Wichita Falls. They weren't complimentary.

"What happened? When did it all change?" I asked.

"Oh, I don't rightly know. Things were pretty bad right along, but for some reason they got real good a couple of years ago. That adoption business must have done it. I'll tell you mister, it's not the same by a long shot."

Before we could talk further I had reached the base.

A while later I was riding in a staff car. I asked the driver what he thought of Wichita Falls.

"I've never met finer people anywhere. This is the best assignment I've ever had." The driver was A1C Dennis Carroll, and he told me something that was difficult to believe.

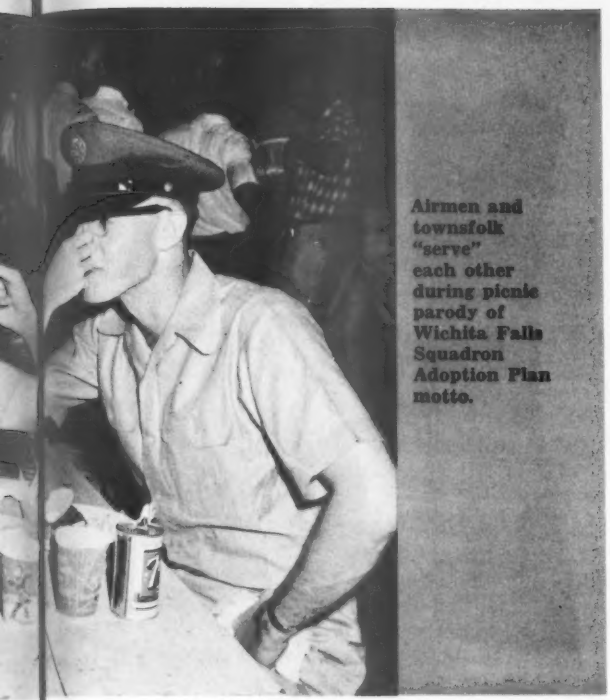
"You know," he said, "I took my wife and kids back home for a long vacation this summer. When we got back I expected the grass to be a foot high. Instead it had been cut by our civilian neighbors. We didn't ask them to, they just up and did it."

When I met Maj. Raymond Seidel, the base information officer, I asked him about the "adoption business" Lee mentioned. Major Seidel said it was called the Wichita Falls Squadron Adoption Program.

Enthusiastically, he talked about how different organizations in town had literally adopted each of the base's 23 squadrons; about their efforts to help each other; about how high morale was.

He explained how Maj. Gen. Thomas Moore, the Sheppard Technical Training Center commander, insisted that this be a program for everyone—not just a community-base council involving staff officers and a few key civilians. He wanted every airman to have a chance to participate and practically all of them have. From 12,000 to 15,000 of the base's 18,700 personnel, in one way or another, have been put into direct contact with area civilian residents.

My skepticism must have been apparent. "Roam around and see for yourself," he said. I told him I would especially like to talk to cross sections of both military and civilian populations. A phone call gained



Airmen and townsfolk "serve" each other during picnic parody of Wichita Falls Squadron Adoption Plan motto.

me access to the Airmen's Club. The club itself is excellent. Ultra-modern, it comes complete with a dance studio, two TV theater lounges—one for couples only, recreation rooms, barber shop, and a huge refreshment parlor—each luxuriously appointed. As many as 2,000 airmen use the club on a single evening.

Chatting with the airmen or eavesdropping on nearby conversations, you get a quick confirmation on what the major tells you.

"This is the first night I've stayed on base since coming here last week. With a club like this I guess you know how much I like the town."

"This is the first time I've ever gone to a used car lot and not have them pressure me."

A1C Myra Maddox serves WAF birthday cake to Business and Professional Women's Club President Margaret Hall during Sunday afternoon tea at WAF Sq. quadrangle.

Morale, even among the normally homesick basic airmen, was higher than a bubble. Naturally there were gripes, but they were minor and small in number.

So What's A Few Bucks?

Martha Jobe is a most attractive young lady. She earns her salary by teaching at the club's dance studio and serving as a scrub nurse at the Wichita Falls General Hospital. The 20-year-old former Tulane Nursing School student is a native of Wichita Falls.

People like Martha and the studio she works for have done a lot to endear themselves to Sheppard. Exactly how was best illustrated by A3C George Oldbury, of Redding, Calif.

George had been at the base, attending jet mechanic school, for all of a month when he signed up for a $75 dance course. "I discovered after I had signed the contract that it was more than I could afford. When I told the studio about it they voluntarily dropped me to a $35 course. There was no fuss at all; was I ever relieved."

Martha made a point of telling how her parish, the Grant St. Methodist Church, now makes a practice of inviting all newcomers from Sheppard who attend services there home to Sunday dinner.

CMSgt. Jim Freyburger, a 45-year-old native of Texarkana, Ark., has been around the military for 22 years. How does he feel about Sheppard?

"I always felt Fort Riley,, Kans., was my best duty station, but this far surpasses it. I'm thinking of retiring here."

A training department NCO at Sheppard for the past six years, Sergeant Freyburger went on to talk about how friendly the churches, fraternities, and merchants had been. "Naturally, merchants are in business to make money, but they don't seem that way—they really make you feel at home."

Like many others he told about the Squadron Adoption Program and how his outfit was among the first sponsored by the local Lions Club. Somehow, with everyone, the talk kept returning to the adoption plan. The program obviously was the key factor, the vital ingredient which had changed mutual animosity to friendship, cooperation, and plain neighborliness.

The Squadron Adoption Program has nothing to do with orphanages. As Jim Montgomery of the Kiwanis Club put it, "You might say that we're trying to be sort of 'foster parents' for the airmen. We want them to feel that Wichita Falls is their home."

Here are some of the program's results:

★ More than 600 airmen from the 3750th M&S Group were recently entertained at Wichita Falls' Beverly Country Club for an evening of golf, volleyball, games, dancing, and dinner. Perkins-Timberlake Co. picked up the tab.

★ Over 600 airmen from the 3769th School Sq., saw a real Texas-style wild steer roundup (dehorning, branding, vaccination—the works) at a local ranch. The visit and chuck wagon barbecue were hosted by the First Wichita National Bank.

★ White Stores Inc. has entertained over 200 men

3769 Sq. airmen get a "close look" at buffalo roaming on nearby Carter McGregor ranch.

from the 3750th Civil Engineering Group at luncheon tours, plays, stage shows, and musicals.

★ Four local ranchers have merged to sponsor the entire 4245th SAC Wing. The whole unit was invited to a rodeo and barbecue at the 500,000-acre (that's 65 miles across, son!) Waggoner Ranch.

★ Over 1,000 gratis tickets to Wichita Falls Coyote football games have gone to the 3767th School Sq., compliments of the Rotary Club.

★ Free in-town swimming pool privileges go to all members of the 3768th School Sq., courtesy of the Optimist Club.

★ 3761st School Sq. airmen are invited home each weekend by Lions Club members. They also receive free ducats to local drag races, movies, wrestling matches, and concerts from the club.

★ Free copies of the *Wichita Falls Times and Record-News* and tours of the newspaper plant go to the 3770th School Sq.

This is only a smattering of what Wichitans have been doing for Sheppard in the past two years. Hunting parties, picnics, fashion shows, watching an oil well being brought in, special parties and dances, bowling and golf tournaments, gifts of TV sets, patio and dayroom furniture have all been common.

When the base hospital's 10,000th birth was recorded last August 17, the proud parents, AIC and Mrs. Lyle Seever, were doubly rewarded. Seever, a "foster child" of Perkins-Timberlake Co., received a gift certificate from that store. Kiwanians, who sponsor the hospital, weren't to be outdone. In true Texas fashion they deposited a trust fund account for the newborn Seever's future education.

USO activity has increased sharply. Miss Miltrie Sharp, USO's program director, told me that more than 100 volunteers take part in its varied activities. Some have donated as many as 60 hours' time in a month.

Harold Hallett, USO director at nearby Lawton, Okla., said, "I've been with USO in all parts of the country for 22 years and I've never seen anything like what has happened in Wichita Falls."

All 23 of Sheppard's squadrons have sponsors who take a direct interest in that group's activities. Besides those previously mentioned, affiliations have been established by the Junior Chamber of Commerce (3750th Tech School); Parker Square State Bank (3771st School Sq.); City National Bank (3764th School Sq.); Wichita County Bar Assn. (Technical Training Center); Sears Roebuck & Co. (3750th ABG); Southwestern Bell Tel. Co. (3760 School Sq.); Texas Electric Svs. Co. (3766th School Sq.) McClurkan's Dept. Store (3763rd School Sq.); Business and Professional Women's Club (WAF Sq.); Fedway Dept. Store (3772d School Sq.); Southwest Rotary Club (3765th School Sq.); and SKYD-TV (AACS). But everyone wants to get into the act.

Back in the days of World War II, airmen at Sheppard had three major complaints: the wind and sand blew constantly; the water tasted terrible; and there wasn't a tree within miles. More than a decade ago Wichitans built a new reservoir which now supplies clean, sweet water. It was only recently that another of nature's oversights was corrected.

Ben Blanton is an idea man. That is he's paid to come up with ideas in his capacity as promotion manager of the *Wichita Falls Times*. When he suggested Wichitans chip in and buy trees for Sheppard's barren 5,000 acres no one imagined how successfully his brainchild would grow.

Under the auspices of the Squadron Adoption Program and the Wichita Falls Nurseryman's Assn., over 700 pecan, pear, apple, plum, American elm, and mimosa trees have been purchased by over 225 donors and planted on the base. They provide not only badly needed shade and greenery but will give airmen a chance to sample Texas fruit during the harvest season. Ben, who hasn't figured out a way to divert the hot wind yet, tells us that the tree-planting drive will be repeated annually.

Cooperation is Mutual

It hasn't been a one-way street, however. Sheppard's airmen have gone overboard to repay the many courtesies which have been extended. Thousands of civilians have been invited out to the base for tours, picnics, luncheons, ball games, golf and bowling matches, pool parties, and variety shows.

Nor is the program limited to fun-making endeavors. In the past year airmen have worked side-by-side with Lions Club members painting in-town boy scout buildings. They've helped in the annual Optimist Club Christmas charity tree sale, in the local bicycle safety

ram ramrod Taylor speaks to Col. B. Campbell.

Rotary president chats with 3767 Sq. engine mechanic students.

check drive, and in numerous other community projects. Perhaps the best barometer of how the base feels about Wichita Falls these days is reflected by United Fund campaign donations. During 1959 base personnel contributed $8,000. Their 1960 offering topped $21,000.

Things like this don't just happen. Why did Wichita Falls, a thriving oil and cattle center of 101,000 (with bank deposits of $199 million) that resented the intrusions of airmen, suddenly change?

It takes just one spark of energy to get things going. The vehicle for goodwill had always been there, but it remained for a retired Air Force colonel to step on the starter and set the "wheels" in motion.

Floyd Taylor is a remarkable man. Few persons one meets in life are possessed with such refreshing sincerity and dedication—with no strings attached. Floyd Taylor is one of these few. The esteem with which he is held by everyone in town and on the base, is inspiring to behold.

In early 1959 he conceived the idea of a real, honest-to-goodness people-to-people program. He spent days on end contacting citizens and organizations and then squadron leaders at the base to lay the groundwork. The idea was officially adopted (Rotary-3767th School Sq.) in April 1959. Few expected it to work. But it did!

"What has happened here is something that money can't buy. We're very proud to have a part in this. We're still working at it. It's not what we want yet," said Rhea Howard, *Wichita Falls Times* editor and publisher.

Sheppard has changed a lot in the past two years. Missiles and jet bombers have been introduced and already are as familiar as cattle grazing on a pasture or an oil field drilling rig. Extended training programs and new construction projects, including a six-story multimillion dollar USAF regional hospital, have created a "boom town" atmosphere.

According to the Wichita Falls Chamber of Commerce, 27 cents of every dollar in town is generated by the base.

Actual start of operation by the 4245th Strategic Wing with its B-52 *Stratoforts* in January 1960 followed $30 million in construction, including the 13,500-foot runway. Missile training now is one of the vital missions, with Sheppard the prime training center for the *Atlas, Titan* and *Thor*.

Rhea Howard said, "The economy of Wichita Falls is wrapped up in that base. We appreciate the fact."

Skip the Formalities

You hear a lot about General Moore, both in town and on the base. How he devoted numerous hours to the Squadron Adoption Program, but how it was all done behind the scenes. How he steadfastly refused to attend various activities for fear his very presence would disrupt the feeling of ease among airmen. How he shuns personal publicity as if it were a plague.

As Colonel Taylor said, "One thing has made this program really click. It's direct contact. General Moore told us to work directly with the squadrons, eliminating all the time involved in dealing through headquarters."

Later the general explained how the adoption program was intended to serve the grassroots level. He steadfastly spoke of what others had done and never once spoke of his own involvement.

Lest you think General Moore is on the easy side, two inspections a week are SOP at Sheppard. You don't see a blade of grass in need of cutting; a piece of litter anywhere, nor a sign of disrepair. Nor do you see a single duck-tail haircut or shabbily dressed airman. Fatigues are not permitted off base, not even to and from duty.

You see higher morale than probably you have ever witnessed elsewhere. Statistics tell the story. The base had a total population of 18,712 including trainees, foreign students, and patients. Only 16 were awaiting trial and a total of 10 AWOLS were listed.

They've found the human touch in Wichita Falls and the words which appear in both the old and new testaments prevail:

"Love thy neighbor as thyself."

—Leviticus XIX, 18; Matthew XIX, 19.

The inward feeling both townsfolk and airmen enjoy, the satisfaction of giving to each other far outweighs the pleasure of receiving. The spirit of sharing, the display of action through deed and word, is profound.

So how are things at the base these days, Colonel Taylor?

"What base? As far as we're concerned there is no base. It's all a part of Wichita Falls."

THE SENTINEL

Photos by SSgt. ALTON McDOUGAL
Eglin AFB, Fla.

Vigilance in these trying times knows no respite, no holidays, no relaxation. It must be eternal, for that is the price of liberty.

Wherever the weapons of our deterrent forces are poised and ready, they are protected from sabotage by men whose lot is a lonely one. They are the sentinels —the air policemen, the security forces who around the clock endure scorching ramps and broiling sun; icy nights and howling winds; biting sand and choking dust; flight lines busy and bustling by day, lifeless and lonely by night.

Here is the story of one such man on one such night. He could be anyone of thousands of APs, anywhere. He happens to be A2C Joe Fiems, a member of the 4135th Combat Defense Force. His job: Protect the combat ready bombers, missiles and property of SAC's 4135th Strategic Wing, based at Eglin AFB, Fla.

First a stop in Central Security Control where he gets some final instructions on the night's duty from A1C W. Bryson, communicator-plotter.

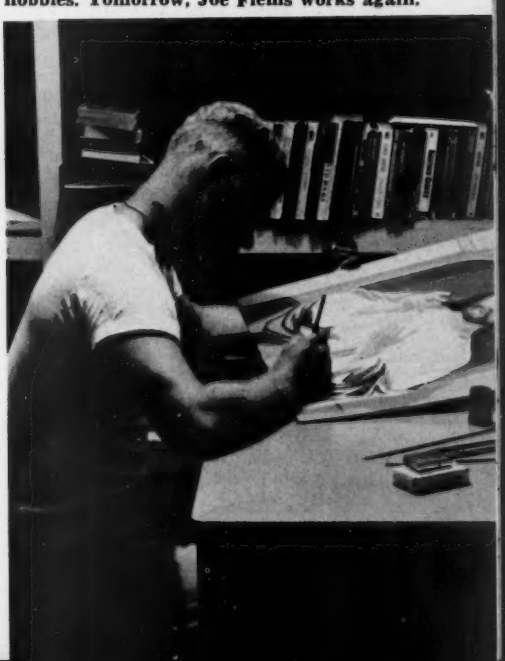
Then, the weapons. From A1C Elton Flowers, he gets his carbine, .38 calibre revolver and his ammunition; nearly ready now to go on post.

Meet Joe Fiems, A2C, Air Policeman. He's preparing for a night out—on the ramp.

The guardmount, a regular formation for the sentinels, brings Joe under the eye of TSgt. Matthew Calder, inspecting NCO.

The long, eight-hour vigil begins. Night sounds hide the silence as his ears and eyes strain for anything unusual. Then a break, as A1C Wheeler brings coffee.

The tour is over. A day's rest, time for hobbies. Tomorrow, Joe Fiems works again.



SLANTS ON SPACE

The Earth will be at perihelion on January 2 when its orbit brings it closest to the Sun—a distance of 91.5 million miles, in round figures. Aphelion for 1962 comes on July 4 when the distance to the Sun reaches the maximum of 94.5 million miles.

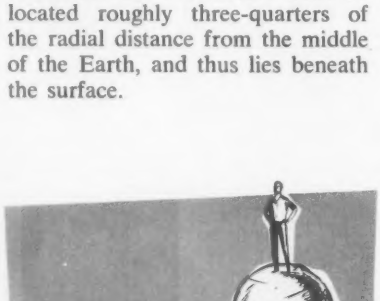
Name's the same, alas. There are two Ganymedes in Space. One is a satellite of Jupiter; the other, an asteroid or pygmy planet. It would be difficult to mistake one for the other, however. The satelite, discovered by the great Galileo in 1610, is about 3,200 miles in diameter. The planetoid, found in 1924, measures a scant 20 miles across. Some scientists, however, dislike any duplication of names for celestial bodies and prefer to call the second Ganymede just 1036, the chronological dogtag number assigned it in the catalogue of asteroid discoveries.

The name, by the way, really belongs to a mythological youth of great beauty. This Ganymede, legend has it, was carried off into the heavens by an eagle to be cupbearer to the gods, so there is a Space angle involved since way back then.

Where is the center of gravity in the Earth-Moon relationship? Somewhere out in the Space gap of almost 240,000 miles which separates the two bodies on the average? No, that gravitational center is underneath your feet, and always closer to the soles of your shoes if you happen to be on the side of the globe that faces the Moon at a given time.

To be specific, the mean distance from the mid-point of the Earth to the surface is 3,960 miles. The center of gravity for the Earth-Moon system is 2,903 miles from that same mid-point, or a shade short of 1,060 miles beneath the surface.

The Earth and Moon move around the Sun as a system, but it is their mutual center of gravity (not the Earth, itself) which travels in the ellipse which conforms with Kepler's laws of planetary motion, hence the two bodies are actually circling that gravitational point. The Earth has a mass some 80 times greater than the Moon's. The Moon is approximately 60 terrestrial radii from our planet. Applying Newton's law of gravitation, we are able to determine that the gravitational center for the two bodies must be located roughly three-quarters of the radial distance from the middle of the Earth, and thus lies beneath the surface.



Anyone curious about how much he (or she) would weigh on Jupiter need only take the poundage figure which an earthly scale shows and multiply it by 2.6.

Our pygmy planet: If the Earth's volume could be increased some 1,300 times, our globe would then be approximately the same size as Jupiter, the giant of the family revolving about the Sun.

The diameter of the Sun, 865,400 miles, is approximately 400 times that of the Moon, which measures 2,162 miles. The Sun also is roughly 400 times farther away from the Earth than the Moon at mean distance. This is one explanation why both the solar and lunar discs seem about the same size when we see them with the unaided eye from our planet.

Variable stars are so called because their brightness is subject to changes, both real and apparent. They are divided into two major categories.

Intrinsic variables are stars whose brightness actually register either marked increases or declines in intensity. A definitive explanation for this behavior is lacking. The belief is that it occurs because of some disturbance in the star's previous atomic structure or processes.

Extrinsic variables are members of stellar systems, numbering two or more stars which revolve about each other in a plane visible to observers on our planet. As these variables orbit, they produce the effect of one eclipsing the other, partially or totally. Since such star systems are so distant from us that they appear as a single point of light, the apparent eclipses cause seeming changes in the degree of stellar luminosity.

P.S. Not all star systems belong in the latter classification. Those with members orbiting in a plane *not* in the line of sight for terrestrial observers are excluded.

—WILLIAM A. KINNEY

WHY ENGINEERS GET THAT WAY

Molybdenum trioxide "whiskers" (white area) form on standard aircraft wiring after the wiring has been exposed to simulated re-entry temperatures.

It was the same old game of hide and seek. *Dyna-Soar* was being treated to simulated space flights by Boeing Aero-Space engineers.

The metallurgists were happy. With a special coating, they had almost completely stopped the temperature-resistant molybdenum from oxidizing, even when heated up to 1,500 degrees. Sure, there was a bit of grayish vapor floating around at these temperatures because air was getting through tiny cracks in the coating. But this little bit of oxidation wasn't enough to weaken the metal.

Murphy's Law, however, or *THAPSM* (gas-eating space monster), or just a plain old-fashioned WW II gremlin was giving the electrical engineers fits. Half the electrical system was shorting out at the high temperatures. Time after time they stopped the flight, waited for *Dyna-Soar* to cool, and checked the systems out. Perfect. Not a sign of a short circuit. The insulation was good. Nothing unusual except some little white "whiskers," identified by the chemists as molybdenum trioxide, growing on the wiring. The whiskery stuff, crystals formed when the gray vapor cooled to about 500 degrees, made good insulation itself.

But these people were research and development engineers. Real curious types. They wondered if the crystals lost their insulating properties at high temperatures. It might turn out to be a superinsulator for superconductors. They tried it to see.

The stuff had a schizoid personality! It no sooner vaporized than it became a very good electrical conductor. Good as wire nearly. And it offered a shorter path.

Those insulating Dr. Jekyll crystals turned into short-circuiting Mr. Hydes at the high temperatures, then resumed their insulating innocence before *Dyna-Soar* cooled enough to lay an instrument on her. This sort of frustration could warp even an engineer's personality.

But that's another spacecraft problem solved now. The Aero-Space engineers at Boeing are going to encase *Dyna-Soar's* wiring in a metal sheath that fits like a Monroe dress and foils the vapor. A mile of the sheathed wire will weigh only 40 pounds and is cheaper than a psychiatrist.

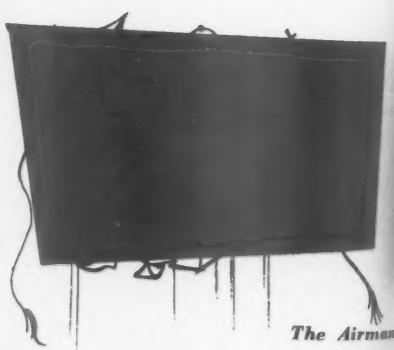
"I don't care who you are, fat man. Get those reindeer off the alert barracks."

It's fundamental!

The fuel makes

THE MUSCLE OF A MISSILE

by MSgt. FRANK J. CLIFFORD
Airman Staff



NO DATE HAS BEEN ASSIGNED to the mysterious disappearance of a Chinese named Wan Hu, but all authorities are agreed that he vanished amid smoke, flame, and the thunder of rockets sometime around 1200 A. D. According to history (some say fable) Wan Hu built a vehicle, the main characteristics of which were two kites, 47 rockets, and a seat. Upon his signal assistants touched off the rockets. The whole shebang went up with a fearful roar and Wan Hu was never again seen in those parts—or any place else.

Wan Hu was, in essence, the embodiment of adventurous, inquisitive, restless man. The urge to go a little bit farther, faster, gripped him as it does the rocketeers of today.

Were he alive now, Wan Hu could easily adapt himself to the much more sophisticated atmosphere surrounding rocket developments, and especially the fuel that makes them go. For fuel is the key to farther and faster.

Since World War II, liquid fuels have been the "fuel of choice," probably because of the extensive experiments and developments made with this form of propellant. Lately, however, solid fuels have moved from the laboratory to the launch pad. Wan Hu, who must have used solid fuel in his machine, would be delighted to learn that scientists now agree they are only on the threshold of solid fuel potential.

Other Chinese tried using solid-fueled military rockets about the time gunpowder was developed. In the battle of Peking, 1230, they credit their victory to crossbow-launched rockets which inflicted heavy casualties on the attacking Mongolian cavalry.

The British used them against us with negligible results in the War of 1812. Their use was observed by Francis Scott Key during the bombardment of Ft. McHenry. Key, a prisoner aboard a British man-of-man in Baltimore Harbor, watched the rocket attack and noted: "the rocket's red glare, the bombs bursting in air" and included these lines in the hymn that was to become our national anthem.

Will It Burn?

In their search for the ultimate in rocket fuels and propulsion systems scientists have experimented with a bewildering variety of elements and chemical compounds. Some substances investigated bear the title "exotic"—which they are: rubber asphalt, nitroglycerine, nitrocellulose, alcohol, liquid oxygen, aluminum and magnesium metal compounds, to name a very few. The general rule seems to be that if a substance will burn, or can be made to burn, it might very well be tested in the quest for a *dependable* fuel with a high *specific impulse* that is *relatively* safe and easy to handle.

Relatively safe and easy to handle is not a phrase lightly taken by propellant engineers. Most practical rocket propellants *are* extremely dangerous but some are vastly more dangerous than others. (Propellant, as the term is used in this article, means a combination of chemical compounds, such as kerosene, or an element such as hydrogen, combined with an oxidizer such as oxygen.) Propellants that are comparatively easy to handle cancel out this agreeable advantage by having a low *specific impulse*.

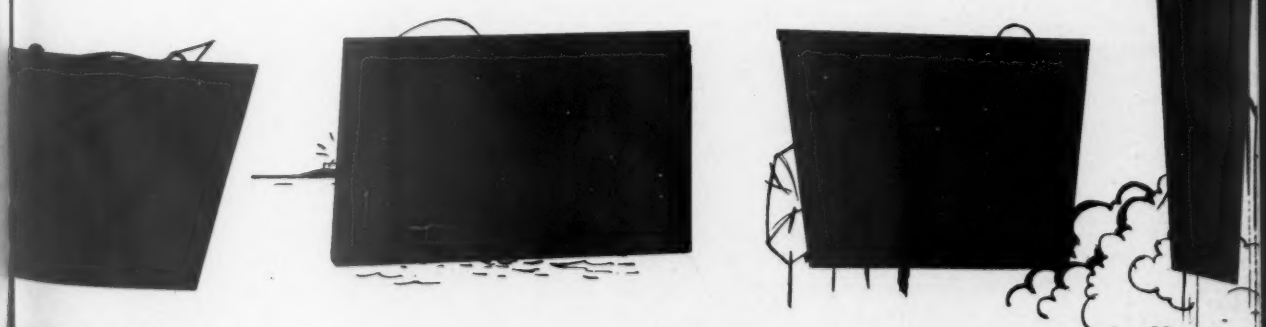
Specific impulse is defined as the number of pounds of thrust which can be obtained by burning one pound of fuel per second. Thrust results when the hot gases are propelled through a nozzle opening. Unconfined burning of the propellant would produce a meaningless explosion or fire. Translating specific impulse into the familiar "pounds" of thrust is a custom-tailoring task that must consider the engine which burns and discharges the hot gases and the burning rate of the propellant combination.

It is mainly used by propulsion engineers as a yardstick to measure relative propulsive power of fuels when employed under *identical* conditions. Higher specific impulse means higher energy per pound. Generally, the highest possible specific impulse is the most desirable for a given mission since lower total propellant mass (weight) is required.

(Editor's note: For those not satisfied with the above definition the following is offered. Given: an engine thrust of 56,000 pounds achieved by burning 19,000 pounds of fuel in 70 seconds. To determine the specific impulse of the fuel use the following formula:

$$\text{Specific Impulse} = \frac{56{,}000 \times 70}{19{,}000} = 206 \text{ Specific Impulse}$$

Rocket propellants in use today have specific impulse ratings ranging from 160 to about 400, the higher ratings going to the liquid fuels. In World War II the



Germans re-introduced to the world the military rocket when they sent a number of their liquid-fueled V-2s crashing into London after supersonic flight from launch sites almost 200 miles away on the Baltic coast. Using an alcohol/water fuel and liquid oxygen as an oxidizer the V-2 generated a specific impulse of about 210.

Interesting comparisons can be made between this primitive ballistic missile and the more sophisticated *Atlas,* probably America's best known intercontinental ballistic missile. In its usual configuration, the airframe, tankage, engines, and guidance system of the V-2 weighed 8,690 pounds, fuel weighed 19,310, and the warhead 2,150, to make a deadweight total of 30,150 pounds. It achieved a thrust of 60,000 pounds which gave it a speed of 3,500 miles per hour at burnout and a maximum range of a little less than 200 miles.

The *Atlas,* using a kerosene fuel and a liquid oxygen oxidizer, produces a thrust in excess of 360,000 pounds to lift its maximum gross takeoff weight of about 260,000 pounds. A recent *Atlas* flew down the Atlantic Missile Range from Cape Canaveral, Fla., to score a near bull's-eye on an Indian Ocean target 9,000 miles away.

While this is quite a giant step from the V-2 it is even a much bigger step when compared to the range and performance of the "original" liquid-fueled rocket of Dr. Robert Goddard who began his experiments before World War I. Because of his pioneering work, Dr. Goddard, an American, earned an internationally recognized reputation as the father of rocket propulsion.

In the time-honored tradition that has become a universal article of faith when a new idea is presented, Dr. Goddard was dismissed as an odd-ball given to tinkering with complicated gadgets with no practical value. Traditionally, too, the raspberry and Bronx cheer was heard loudest in his native land. The Germans, on the other hand, seemed to think he had something—they followed his experiments with Teutonic thoroughness and respect.

Mail Order Gantry

Goddard's original launch tower was obtained from Sears Roebuck, who carried the item in their catalog as a windmill tower. Goddard and his machinist assistant, Charles Mansur, removed the fan and other trimmings and bolted an additional 25 feet to it. An early rocket launched from this contraption arced upward and then streaked for Goddard and Mansur, chasing them to cover.

In March 1926 Goddard demonstrated the first practical liquid rocket fuel—gasoline and liquid oxygen. Even though his rocket flew in spectacular fashion engineers promptly proved it couldn't be done. They slipsticked the burning characteristics of his propellant combination, matched their findings against heat transfer tables, calculated the rate of gaseous expansion—and declared the whole proposition impossible.

Overlooked were these facts: the missile *did* fly, and the engineers did their arithmetic using tables and formulae based on the operation of steam engines! There were no other tables at the time. These might have been the same engineers who examined the aerodynamic qualities of the bumblebee and declared the insect a fraud, incapable of even limited flight.

Like a temperamental but overwhelmingly desirable woman, fuels with high specific impulses are likely to be almost too mercurial to handle. They are explosive, toxic, corrosive, cryogenic (gaseous at ordinary temperatures, like oxygen or hydrogen, and must be liquefied to be practical fuels), expensive—or all five.

Such a high-powered lass is a combination of fluorine and hydrogen, classed as a super-high-energy liquid bipropellant with a specific impulse of 410 seconds. Plenty of boost there, but also plenty of handling and storage problems too. Not only is liquid fluorine a very-low-temperature substance, like liquid oxygen, but it is highly toxic and corrosive as well. Even after it is burned its combustion products are corrosive and dangerous.

Liquid hydrogen is crankier and even more treacherous to handle. It will remain liquid only at extremely low temperatures, lower than that required to keep oxygen liquid, and it is forever seeking to escape its container and mingle with the atmosphere. Colorless and odorless, hydrogen is highly explosive and can be touched off by a random spark. But engineers must

This aluminized fuel handler's safety suit is airtight, moisture- and fire-proof. It can withstand temperatures up to 500 degrees, weighs 25 pounds with breathing and communications equipment.

explore places where even angels fear to tread—hydrogen *is* a star performer among liquid fuels and for this reason scientists are willing to put up with its willful ways.

Liquid vs. Solid

For all practical purposes at the present time rocket propellants are divided into two broad categories — liquid and solid. Each has its own unique advantages and each shares common advantages and disadvantages. Liquid-fueled rockets can be shut down and restarted; solid-fueled rockets cannot. Liquid fuel engines are complicated mechanisms; solid fuel engines are essentially super-sophisticated Fourth-of-July rockets with a bare minimum of moving parts.

Liquid rocket engines used in *Atlas, Titan* and *Thor* are *bipropellant,* carrying the fuel in one tank, the oxidizer in another. The two come together in the combustion chamber where they are ignited and their energy released as thrust. Introducing the fuel and oxidizer is a mechanical feat comparable to robbing Peter to pay Paul.

Two methods can be used—pressure or pump. In the pressure system fuel is delivered to the combustion chamber by auxiliary tanks storing an inert gas under high pressure. Mounted atop the fuel/oxidizer tanks this system eliminates the complex pump structure and in so doing erases the danger of pump failure, *but* it demands a weighty, beefed-up tank structure to withstand pressures which may run as high as 500 pounds per square inch. This is not a commonly used system.

Delivering the fuel and oxidizer by pump first of all demands engines capable of delivering several thousand horsepower to drive the pumps. In some rockets these pumps must be able to deliver *several hundreds of gallons per second!* Where to get this power? The Germans drove the main fuel pump in their V-2 with a special turbine using hydrogen peroxide. The commonly used source is a hot-gas turbine, feeding on the missile's fuel supply, which is actually a small combustion chamber. Here engineers must grapple with factors that seem to contradict themselves. They must build pumps of absolute reliability and high performance *but* they must be made with the high precision of a fine watch, rugged as a bulldozer, light as an idle thought *and* small enough to fit into the cramped innards of the rocket.

With a fine, dependable, light-weight pump available the natural place to mount it would seem below the bottom of the fuel tanks. But is this the best place? For most purposes, yes. But what about operation under conditions of weightlessness or zero acceleration which is the rule in outer space? What about fuel sloshing about in the tanks? Suppose fuel sloshed up one side of the tank, leaving the outlet hole "dry" even for a fraction of a second? Would the pump "gasp" inert air, rush it to the combustion chamber and thereby douse the flame or unbalance the combustion mixture? These are some of the problems that bedevil rocket and propulsion engineers.

Some of the finest performers in the liquid fuel category are the *cryogenics,* that is, fuels that must be converted from their natural gaseous state to a liquid form. This involves super low temperatures and frequent "topping-off" of the tanks as fuels in this state must be allowed to bleed off into the atmosphere lest the increased pressure, which rises as the liquefied gas seeks to come into balance with the prevailing outside temperature, climbs to a point which would result in explosion of the tankage.

The need to top the tanks also increases the time lag between the point when the rocket is first made ready for firing and time of actual firing—the longer the delay in the countdown, the more frequent the need to top the tanks. And some countdown schedules call for a wait in the gantry of from 6 to 12 hours.

The Hypergolics

A way around this explosive situation is presented by a new family of storable fuels which require no refrigeration or ignition system. Called by a German-coined word, *hypergolic,* these fuels are a bipropellant liquid fuel and liquid oxidizer that react when brought into contact and achieve ignition temperatures without outside assistance. A small quantity of hypergolic fuel, spontaneously ignited when introduced in the combustion chamber, establishes the initial head and pressure to touch off the subsequent main flow of fuel. Hyper-

golic fuels represent a step toward simplification and weight-saving because they eliminate the need for glow-plugs, pyrotechnic igniters, or igniter-chamber assemblies. Morever, they offer the added advantage of throttling and can be shut down and restarted at will.

The Air Force's *Titan II,* an ICBM, is fueled by storable hypergolic propellant. This gives *Titan* an almost instantaneous reaction time which makes it, in this regard, comparable to solid-fueled missiles. While engineers figure the overall cost of *Titan,* in absolute dollars and cents, to be about four to five times the cost of *Minuteman,* they also point out that *Titan* is the least expensive ICBM in costs per unit of payload.

Dr. Albert Hall, Vice President of Engineering, the Martin Company, in a May 1, 1961, talk before the National Federation of Security Analysts, offered this interesting comment: "A liquid-fueled booster such as used on the first stage of *Titan II* can be made recoverable. Without booster recovery, the situation might not be very different from this: An airline loads its jet transport full of passengers in Los Angeles, flies to New York City, unloads the passengers, and *throws away the plane.* Thus, to boost space payloads economically, the booster system must be recovered for reuse and only liquid propellant systems lend themselves to this recovery."

The field of rocket propulsion is one where the contradictory and the paradoxical are commonplace. Hence it is not surprising that the oldest form of propulsion, solid fuel, has emerged after centuries long siesta in the shade of history. Solid fuels now loom large on the rocket scene, today they form the "second generation" of missile propellants. Their reliability and special characteristics — ease of handling, cheapness, instant readiness, simplicity, storability, mobility—make them especially attractive.

Gummed Up Success Story

While man has been tinkering with solid fuels in one form or another for centuries, the story of modern solid propellants is less than 35 years old. What was to eventually sire the dull grey compound that now propels the *Minuteman* and *Polaris* came into being in the Chicago laboratory of Dr. J. C. Patrick. He mixed ethylene dichloride and sodium polysulfide in his search for a cheaper anti-freeze solution. The experiment was a bust—his stirring rod mired to a halt in a thick, unlovely smelling mess, certainly not the stuff to pour into a radiator.

After some reflection Dr. Patrick decided what he had whipped up was a gummy something akin to rubber. In several subsequent experiments he learned that he had, in fact, created the first synthetic rubber made in America. Moreover, his product was superior to natural rubber in several important ways. It did not swell, deteriorate or alter its physical characteristics in the presence of gasoline, chemicals and air. In a burgeoning chemical age there was use for such a material.

Dr. Patrick, and associates, set up Thiokol Chemical Corp. in 1929 to manufacture the stuff. The name of the firm sprang from a marriage of the Greek words for sulfur and glue, a very casual way to describe an organic polysulfide polymer, a complicated chemical combination of sulfur, carbon, and hydrogen. For a time the company prospered but eventually was hard pressed by more advanced synthetics made by other firms. Things picked up in World War II when it was learned that other products derived from research by Thiokol had tremendous possibilities in a broad range of industrial uses. Over the years a large family of products grew from the original formula.

One of these, a liquid polysulfide polymer that set into a solid solvent-resistant material that could be moulded and even machined, was to develop into the fuel that fires *Minuteman.*

Soon after World War II the Jet Propulsion Laboratory of the California Institute of Technology found that by mixing a quantity of oxidizer with the liquid polymer the resulting material would burn with great intensity and generate great volumes of gas. Just the stuff for rockets.

At the same time the liquid-fueled rocket was the *prima donna* of the rocket world. The U. S. had a quantity of captured German V-2s to experiment with, as did Russia, who also removed the entire German rocket installation at Pennemunde to Russia. Thoughtfully, they also rounded up an impressive batch of German scientists to round out the package.

While liquid-fueled engines occupied stage center, solid-fuel experimenters were going along in measured pace, their gait more than somewhat hobbled by lack

After a batch of solid-propellant fuel is poured into casting cans from mixer, technicians use hoe-like trowels to clean out residue. Photo courtesy of Thiokol Chemical Corp.

Fuel and propellant handlers at Cape Canaveral check acid oxidizer for contamination. Slightest drop of acid must be washed away immediately.

of money and the glamour of liquid engines. Two of the main drawbacks in stimulating interest in solids were: demonstrated efficiency of liquid engines, and lack of serious, continuous, scientific investigation of solids.

Search for Solids

General Bernard A. Schriever, then head of the Air Force Ballistic Missile Division, and now commander of the Air Force Systems Command, decided in 1955 that the time was at hand to investigate solid propellants. He tapped Col. Edward N. Hall (now retired) as chief investigator. Hall was a missionary who had long preached the virtues of solids and he set to his task with a will.

Alas, his zeal was somewhat dampened—but not quenched—as his "study" developed. At the time, the standard solid-fuel rocket was a heavy gauge steel tube. The fuel was cast separately and slipped into the case where it was held by additional, and weighty, structural members. In burning the fuel was consumed from one end to the other—like a cigarette—subjecting the case to a progressive wave of concentrated heat and pressure. To withstand the heat heavier rocket cases would be needed; the bigger the rocket, the heavier the case. This alone would soon put a ceiling on solid-fueled rockets.

Liquid-fueled rockets had swinging thrust chambers that responded to control systems; solid rockets had fixed chambers. Liquid-fueled rocket motors could be throttled or shut down on command; solid-fueled rockets, once ignited, burned without restraint to burnout. The thrust chambers of liquid-fueled engines could gain a measure of insulation by running the propellant around the flame tubes; solid fuel offered no such "cool" solution to a hot problem. If these problems could be solved what about the terrific "bump" of solid fuels. Liquid-fueled rockets take leave of the earth in a gradual build-up of speed; solid-fueled missiles accelerate from zero to full bore in a quarter of a second; a monstrous strain on the entire structure, but especially on the delicate guidance system so vital to carrying out a mission.

The problems were solved, one after another, but not until some heavy thinking was bent to the task. Among the first things done was to scrap the traditional method of filling the rocket body with fuel. Henceforth liquid polymer would be poured and cured in the case. This eliminated several manufacturing steps and cut weight considerably. The engineers turned to cannibalism to solve the concentrated heat problem and in so doing reduced the weight of the case and increased the dependability and efficiency of the propellant.

The trick was to get the fuel to "eat" itself. This was done by pouring the liquid polymer around a star-shaped mandrel which pierced the vertical axis of the rocket. With this arrangement the entire interior of the rocket would be aflame, burning from top to bottom, and from inside out, with the unburned fuel itself insulating the thin rocket walls. Only at the moment of burn-out would the raging flame reach the casing, and then it didn't matter.

Engineers have developed gimbaled thrust chambers for solid-fueled rocket engines and now these can respond with delicate finesse to guidance systems. Work is being done to develop a throttlable solid-fuel engine. One way of doing this is to cast the fuel as a solid, bonded to the case, and introduce a liquid oxidizer when combustion is desired. Cutting off the oxidizer would douse the flame.

Solid propellants had come of age, and with them came the *Minuteman* and the *Polaris*. Visible, and not faintly, are solid rockets of mammoth size. In the past, because the solid fuel had to be poured at a manufacturing site, the overall size of the missile was limited to what could be transported by air, rail, road, or

Joshua trees on Mojave Desert make weird frame for missile engine test stands at Edwards Air Force Base.

water, to the launch site. This restriction has been removed by the development of segmented fuel sections which can be assembled at the site like piling poker chips one atop another.

Which is the better propulsion system—liquid or solid? There is no hard and fast answer to this question since each has its merits and its faults. Maximum exploitation might be achieved by using various combinations of propulsion in a single vehicle. Thus, a powerful solid-fueled rocket might be used to loft a liquid-fueled "space ship" beyond the pull of gravity. Coasting in frictionless space the liquid engines could be ignited, throttled carefully, and used to propel the craft on a prolonged space voyage. In this environment only a small amount of thrust is needed to reach astronomical speeds.

What lies ahead? Nuclear propulsion is being examined but the tremendous weight of the shielding, plus the difficulty in designing a suitable reactor, moves this method into the distant future. Hydrogen, by virtue of possessing the lowest molecular weight of any of the chemical elements, remains the optimum material to discharge from a rocket. In one plan, liquid hydrogen, stored aboard, would be heated by nuclear reaction to produce an estimated specific impulse of 700.

John C. Lee, Director of Research, United Aircraft Corporation, says this of electrical propulsion systems: "In electrical propulsion, very small forces are produced in terms of the weight of equipment required to produce them. For example, one-pound thrust may require an electrical propulsion engine weighing two tons, including the source of electricity. At first sight this would appear to result in a ridiculous situation, but on further examination this type of device has a good deal of promise for missions to the planets or other long distance exploration.

"By way of example, if you could push a 5,000-pound object with no friction, using a force of only one pound, the object would achieve a speed of about one quarter of a mile per hour in the first minute. At the end of the first hour it would reach a speed of 15 miles per hour, and at the end of the first day it would be over 375 miles per hour. In a month it would have attained the speed of 11,000 miles per hour, and in about two months it would have attained escape velocity. When you boost an electrically powered vehicle out of the atmosphere at perhaps 15,000 miles per hour and continue to add an additional 11,000 miles per hour every month, it soon becomes apparent that you have reached velocities as high as those likely to be reached by any other devices."

Far out? Certainly. But it only serves to show the wide scope of investigations into propellants. The apparent slow acceleration of an electrical propulsion system should be evaluated in context with a three-year round trip to Mars or Venus.

Where will it all end? For man there can never be an end. What is today's goal eventually becomes tomorrow's stepping-off point enroute to a newer, more demanding goal. The past will always be prologue.

The Frank Buck Kit

BRING 'EM BACK ALIVE

by Capt. DANIEL H. SEAL and SSgt. DORMAN K. ROBERTS
School of Aerospace Medicine, Brooks AFB, Tex.

During our relatively short careers, we periodically have entertained the idea that a small, personal survival kit is one essential item well-dressed tigers wouldn't be without. Numerous ideas, most of them very good, have been expounded on the various components of these insurance policies and, right or wrong, we feel moved to present what we think is a nice little package of goodies that would be welcome wherever airmen may make unscheduled descents.

This kit does not purport to replace issued kits, but to supplement them. It could, however, take the place of the more sophisticated models in some embarrassing emergencies. It will provide one man with 3,275 calories, coupled with ample proteins and carbohydrates. These essentials are in a palatable form fairly easy to prepare, readily available and preservable in their natural state. The kit will also help its user cure his ills, live off the land, purify his water, establish his travel route—all this though it weighs less than two pounds. Impossible? Well, let's see.

This miniature combination commissary and sporting goods store, with a built-in dispensary, comes in two parts. It will fit into two pockets of a flying suit. The first and prime component is the food. The other is the survival and first-aid items.

The basic item in the food pack is pemmican. Now, before you quit reading in disgust, be assured this isn't just plain old GI pemmican, but a new improved recipe that is quite tasty. Its ingredients are equal portions of hickory-smoked dried beef and pecans, plus one half portion of dried pitted dates. Utilizing Ma's food chopper, or small meat grinder, grind these ingredients separately, then mix them together and grind the whole batch again. Pack in bars of approximately three ounces, cover first with two layers of thin plastic sandwich wrap, then a double thickness of heavyweight aluminum foil. The foil can then be used for signaling, cooking or eating utensils, and about 40 other various and sundry purposes.

Supplement the pemmican with three one-ounce bars of sweetened chocolate, four bouillon cubes, four lumps of sugar, six packets of instant coffee, one packet each of chile and onion powder, three vitamin pills, and two packets of dried cream. Package all this in a 5 x 9 inches heavy plastic bag wrapped with about three feet of adhesive tape.

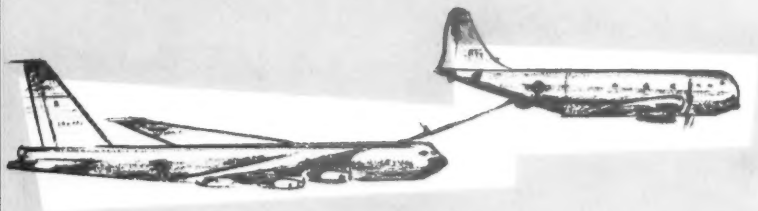
Next obtain a standard aluminum match container, break approximately 50 waterproof matches in half and pack them heads up and down in it. This affords twice the capacity of regular length matches and prevents explosions.

Into a 3 x 5 inches hard plastic container, approximately one inch deep, pack the remaining hardware. For first aid our dehydrated dispensary contains one vaseline gauze pack for burns, eight band aids, eight needles of assorted sizes, six safety pins, 12 APC tablets, 12 salt tablets, and a single-edged razor blade. At first glance this might seem austere, but I think you will agree that it is versatile and acceptable when coupled with a parachute. For utilitarian purposes we included about a dozen fish hooks of assorted sizes, some nylon and steel leaders, a button-sized compass, about five feet of copper wire for snares, 50 iodine tablets for water purification, two heat tabs, and a lightweight plastic bag about 5 x 8 inches neatly folded. All the tablets are wrapped in lightweight plastic encased in aluminum foil. Toss in a fishing instruction booklet from the survival fishing kit and wrap the whole bit in ample aluminum foil and adhesive tape and you are in business.

Well, there it is. We realize every luxury encountered in American life is not included, but space is limited. We think a man could survive for a considerable time with our kit. Regarding its components, some items may not suit your individual likes or dislikes, but even if we provoke a decent amount of thought we will have contributed something. This alone is worth our effort.

Editor's Note: We are always interested in brief descriptions of kits designed by individual airmen (reference **Do-it-yourself Anti-panic Pack**, Aug. '61 issue). Anyone else design one?

THE GIFT OF TIME



Sometimes to do the right thing You have to do it backwards

Rigid training and a "backward" approach to a routine procedure helped to extricate a KC-135 from a tight spot over New England. The pilot of the tanker, returning from a refueling mission, found that he was unable to lower the nose wheel while letting down in poor weather at Westover AFB, Mass. After advising the tower of his difficulty, Maj. Howard F. Lippincott, aircraft commander, made several further attempts, finally getting the wheel down, but not locked.

Fuel was running low in the KC-135, making the sticky situation even stickier. Westover Command Post made radio contact with a 347th Bomb Squadron B-52 then in flight near Syracuse, N. Y. Maj. Thomas J. Dunlap, Jr., commander of the B-52, proceeded immediately to the aid of the distressed tanker.

With smooth coordination the entire bomber crew reacted quickly to the crisis. The gunner, TSgt. James L. Toomer, reported that his COMBARS (weather reports) indicated that the weather over Griffis AFB, Rome, N. Y., was the best in the area for a hook-up. The Electronic Officer, Lt. Thomas Carpenter, got a fast celestial fix for the navigator, Lt. Jack W. Sutherland, to plot the interception. Capt. John E. Ryan, copilot, contacted the tanker by radio and advised it of their intentions. A few minutes later, the tanker's blip appeared on the scope of Capt. Will O. Speight, radar navigator.

At the rendezvous point, Major Dunlap flew the bomber into the normal refueling position under the tanker, hooked up to the refueling boom and passed 20,000 pounds of fuel to the tanker by reversing the normal refueling pumps.

Aboard the tanker, Major Lippincott made use of the gift of time by recycling his landing gear. Finally the stubborn nose gear lowered and locked in position. The aircraft landed without further incident, other than a few heartfelt sighs of relief from the crew.

For their part in the episode, Major Dunlap and his crew received some warm words from Maj. Monroe W. Graham, commander of the 347th Bomb Squadron. "A top crew plus hard training paid off. We're very proud of Major Dunlap and his entire crew."

LETTERS TO THE EDITOR continued

B-26 Inquiry

Sir: I have been unable to find a satisfactory answer to a question which has puzzled me for some time. I recognize the fact that USAF has had two B-26 aircraft in its history. Can you give me a few more details regarding these two planes and indicate which fought in Korea?

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APO 199, New York, N. Y.

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Missile Problems

Sir: I believe you have made a serious error in the September issue in the article *Waystation in Wyoming*. The author claims that Warren AFB is SAC's first operational ICBM station. This is not true. Vandenberg AFB, Calif., was in the EWO missile business while personnel from Warren were training at this installation. Training is a secondary mission at Vandenberg and has always been so considered.

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Vandenberg AFB, Calif.

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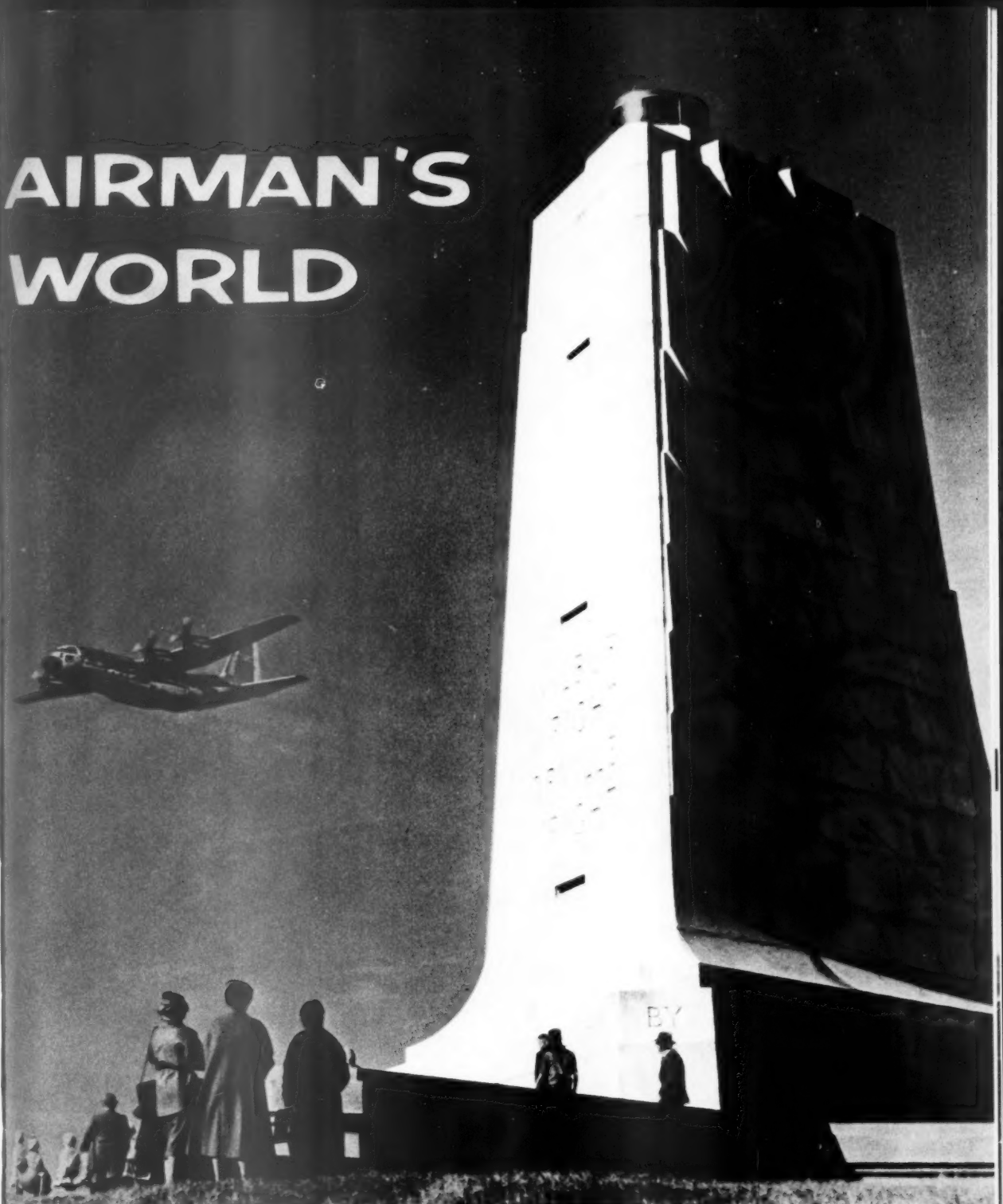
Sir: The picture of Lieutenant Mayhew which appeared in the article *Waystation in Wyoming* raises a question in my mind. I note that his identification-tag chain is visible outside the collar of his shirt. Is this not a uniform violation. Shouldn't the chain be hidden from view?

MSgt. Malcolm Jefferson
Sheppard AFB, Tex.

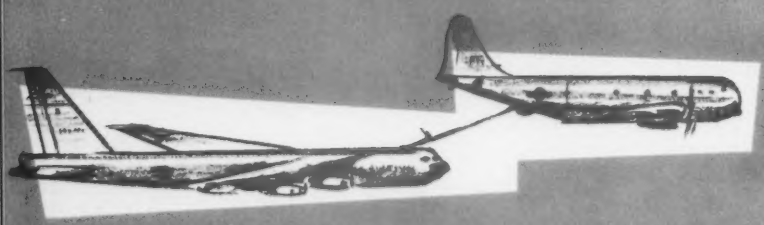
● *We have searched regulation files regarding the wear of the uniform and of identification tags. As far as we can determine, there are no specifications regarding this practice.*

AIRMAN'S WORLD



December 17, 1903, Wilbur and Orville Wright completed four controlled, powered aircraft flights, the world's first. They ranged from 120 feet in 12 seconds to 852 feet in 59 seconds. At Kitty Hawk, N. C., a memorial marks the spot from which they flew—a tribute to the Dayton brothers who made possible the airman's world. This year Public Law 87-291 was passed, officially designating December 17 as Wright Brothers' Day.

THE GIFT OF TIME



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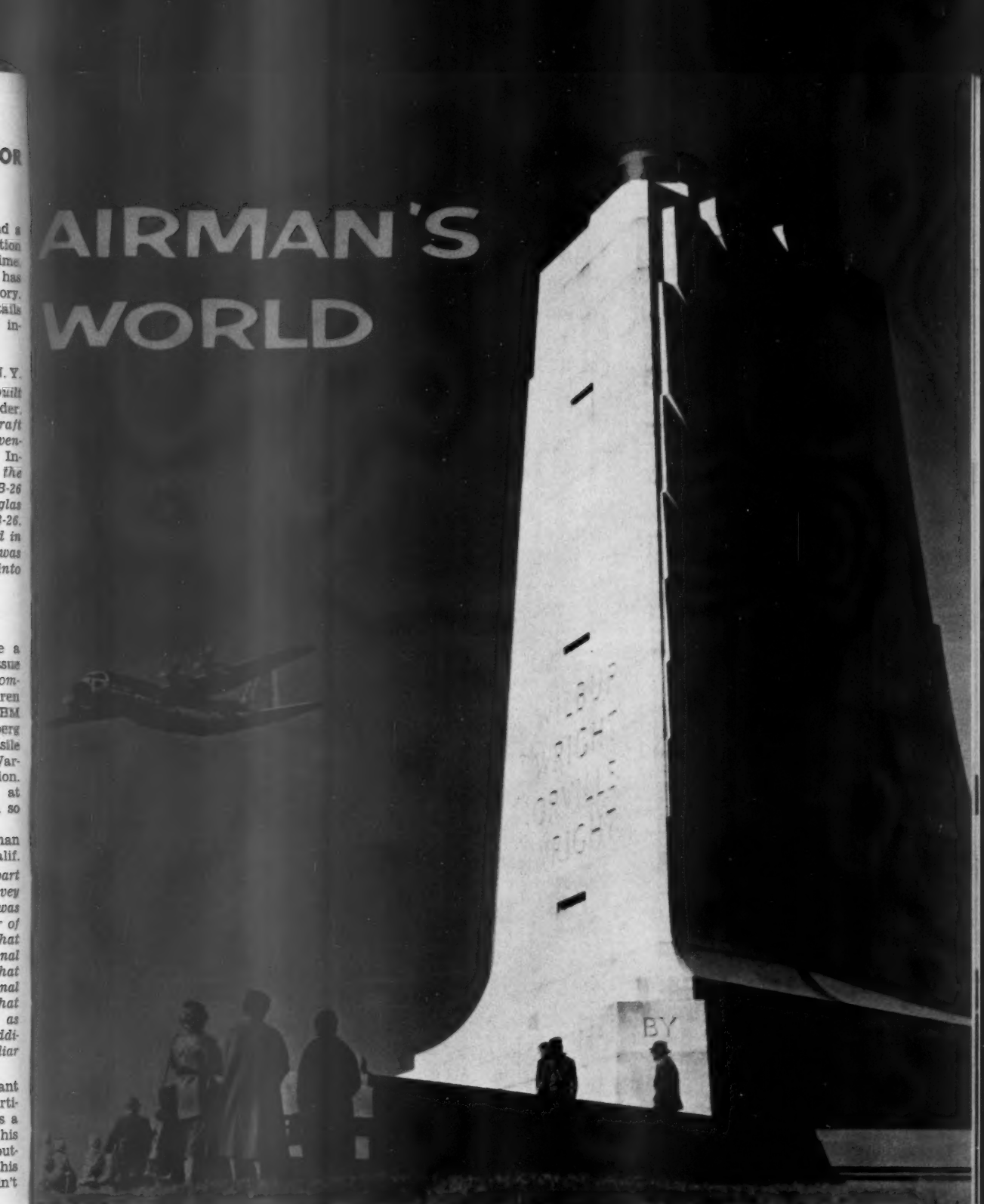
● *There was no intent on the part of the author or the editors to convey the impression that Vandenberg was solely a training base. As a matter of fact, the author offered no claim that Warren was the first operational ICBM base. Rather, he stated that it was the "first of its operational kind." The intent was to show that it was the first designed solely as an operational base without the additional training duty which is peculiar to Vandenberg.*

Sir: The picture of Lieutenant Mayhew which appeared in the article *Waystation in Wyoming* raises a question in my mind. I note that his identification-tag chain is visible outside the collar of his shirt. Is this not a uniform violation. Shouldn't the chain be hidden from view?

MSgt. Malcolm Jefferson
Sheppard AFB, Tex.

● *We have searched regulation files regarding the wear of the uniform and of identification tags. As far as we can determine, there are no specifications regarding this practice.*



December 17, 1903, Wilbur and Orville Wright completed four controlled, powered aircraft flights, the world's first. They ranged from 120 feet in 12 seconds to 852 feet in 59 seconds. At Kitty Hawk, N. C., a memorial marks the spot from which they flew—a tribute to the Dayton brothers who made possible the airman's world. This year Public Law 87-291 was passed, officially designating December 17 as Wright Brothers' Day.

United Effort

Boeing's Wichita (Kans.) Division is responsible for on-schedule delivery of the B-52H to the United States Air Force. Strangely enough, however, only comparatively small portions of the aircraft are manufactured at the assembly facility.

A recent report shows that nearly 4,000 other business firms, both large and small, are currently producing parts of the aircraft under sub-contract. More than two-thirds of these are organizations with less than 500 employees.

In addition to the myriad of companies involved, it is also interesting to note that the contracts were spread geographically over 43 of the 50 states and to companies in the District of Columbia and Canada as well.

Current delivery of the aircraft is proceeding as programmed, and tests of the *Skybolt,* which will eventually be added to the *Stratofort's* arsenal, are also on schedule.

Among the latest efforts in this air-launched ballistic-missile test program was a successful sky drop at AFSC's Air Proving Ground Center at Eglin AFB, Fla.

An inert model of the *Skybolt,* resembling the real product in size, shape, weight, and center of gravity was put through rigid trajectory tests over the 15-mile, high-speed bombing range.

Four of these missiles will become a regular part of each B-52's armament by 1964. Each will have the capability of putting a nuclear warhead on selected targets about 1,000 miles from launch points at speeds up to Mach 5.

Identification Restrictions

USAF Personnel officials recently issued a reminder to all Air Force members and their dependents that official identification credentials are not to be photographed.

In part, the message read, "An increasing number of merchants are using photographic identification systems in connection with check cashing services. Usually the customer, the check and identification credentials are photographed simultaneously. Section 701, Title 18, U. S. Code, prohibits reproduction of United States Government Identification credentials."

Consequently, Air Force personnel are cautioned to utilize some other means of identification when such photo systems are in use at establishments where they desire to cash checks.

FIVE USAF OFFICER-SCIENTISTS have been honored for scientific achievement in the Air Force research and development program. Lt. Gen. Donald L. Putt (USAF, Ret.) made the presentations at the Air Force Association convention in Philadelphia, Pa., on behalf of the Scientific Advisory Board. From left to right are General Putt; Lt. Raymond E. Hunter, Office of Aerospace Research; Capt. Harry F. Rizzo, Lawrence Radiation Laboratory; Maj. Lew Allen, Jr., and Maj. Frederick L. Hafer, Air Force Missile Test Center; and Capt. Alvin P. Hjorten, Air Force Missile Development Center.

Specialty Testing

Final 1961 cycle for Phase III Specialty Knowledge Testing is scheduled for the current month.

Phase III encompasses 11 career fields including Intelligence (20), Safety (24), Air Traffic Control and Warning (27), Communications Operations (29), and Missile Guidance and Control Systems (31).

Also listed are Munitions and Weapons Maintenance (46), Motor Vehicle Maintenance (47), Utilities (56), Transportation (60), Food Service (62), and Personnel (73).

Overseas-based airmen in these fields will undergo testing during the week of December 4. Personnel residing at Stateside stations will have tests made available to them during the following week. Air National Guard and Air Reserve members may take the tests any time during the month of December.

"Desert Rats" Reunion

Members of the 21st Fighter-Bomber Wing during the period when it was based at George AFB, Calif., and Chambley AB, France, will hold their annual reunion, December 14-16, at Orlando AFB, Fla.

Requests for reservations may be made by contacting Maj. William C. Waller, Office of Information, Air Photographic and Charting Service, at the host base.

All arrivals should be planned between noon December 14 and noon the following day. Activities will begin with a luncheon meeting on the latter date and climax with a dinner party that evening.

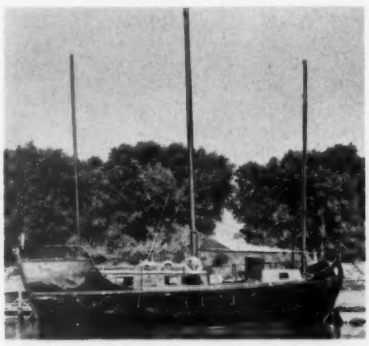
Mother Hen

As usual, fall brings the inevitable tall hunting tales, but here's one accomplished without a gun.

Earlier this year, MSgt. Eiland Helms, stationed at Adair AFS, rented a new home in Corvalis, Ore. During a tour of his new premises, he flushed a hen pheasant from a nest in the backyard. Knowing she would not return to her nest, Helms carefully gathered the eggs and rigged a makeshift incubator.

In a few days, he was the proud father of 15 chicks. He reported his parenthood to the State Game Commission who provided feed, offered their congratulations and told him to keep his brood.

At last report, Helms is anxiously awaiting the day his foster children reach eating size.



SOMETHING NEW HAS BEEN ADDED to the Sacramento skyline and Maj. Phillip R. King, recently assigned to McClellan AFB, Calif., is the man responsible. He moored his hand-built Chinese junk King Kuan in the Sacramento River after its arrival from Formosa. The major built the boat in an Air Force hobby shop during his 18-month tour in the Republic of China. Craft was shipped commercially when he rotated.

Bits of Blue

. . . Officials have announced inauguration of a five-month flight-test program for the B model of the GAM-72 *Quail*. Eight A models will be diverted from current SAC inventories to assure that the program can begin by April 1962.

. . . Goodyear's Aviation Products Division has been awarded a contract to supply wire-brush skids for the X-15. Tests will be conducted by North American Aviation, Inc., to determine whether these skids should be utilized as a permanent replacement for the smooth types now in use.

. . . A J93 turbojet engine, programmed power plant for the B-70, recently completed a 22-hour endurance test under conditions equivalent to 2,000 m.p.h. Tests were conducted in General Electric's facilities near Cincinnati, Ohio.

. . . The Martin Co. has received a $1.5 million contract for production of 424 TGAM-83 *Bullpup* training missiles. They will be utilized in the training program for standard versions of both GAM-83A and the nuclear-capable GAM-83B.

. . . Personnel at Murphy Dome AFS, Alaska, have a unique mascot. "Rusty" is an arctic fox and visits the 744th AC&W Squadron daily to be fed. He is becoming increasingly tame, reports say, and will even sit while begging for his handout.

. . . The Aeronautical Systems Division, Wright-Patterson AFB, Ohio, is currently testing a new 20-inch hypersonic wind tunnel capable of providing a constant flow of heated air at Mach 14. Simulated altitudes lie within the 100,000- to 200,000-foot range.

. . . Students at Keesler AFB, Miss., will begin receiving portions of their instruction via television this month. WKTC-TV, a closed circuit television station, was completed on base in September. Production of training materials and program preparation were undertaken immediately, and the finished product is now available.

Court Calendar

United States Air Force Academy's Falcons kick off their 22-game 1961-62 basketball slate Saturday, December 2, against the University of Washington at Seattle.

The schedule calls for nine games on the road and 13 at home. Also during December, the Falcons will host Hardin-Simmons, Nebraska and North Texas State, and will travel to Provo, Utah, for a road game with Brigham Young University.

January road games are with Marquette at Milwaukee, Wis., Wyoming in Laramie, and Denver in Colorado's capital city. The home card will feature Western (Colo.) State, Wyoming, Colorado State University and DePauw.

In February, the Falcons will host Kansas, Regis, Colorado College, Creighton, Valparaiso and South Dakota. They will travel to Albuquerque to meet New Mexico, to Tucson for a game with Arizona and to Tempe with Arizona State as the opponent.

The season closes on March 3 with a road game against Montana State. Washington, BYU, North Texas State and DePauw are newcomers to the USAFA schedule. The team will be trying to preserve the Academy record of never suffering a losing season.

Airman's Medal

MSgt. Cecil L. Spears, Jr., was recently presented with the Airman's Medal during parade ceremonies at Vandenberg AFB, Calif.

The award was made in recognition of the role he played in the rescue of five civilian-contractor personnel trapped in an underground *Titan* missile operational facility.

In September 1960, a malfunction caused a spill of liquid nitrogen within the equipment terminal. Spears detected the resulting reduction in the normal oxygen content of the air and sounded the alarm.

Grabbing two 40-pound air-breathing devices, Spears then made his way to the trapped workers. He led two to safety and returned with the mechanical lungs, this time accompanied by Maj. James Schafer, launch complex safety officer.

Major Schafer surrendered his lung to the fifth civilian, and Spears led the three to safety. He then returned to the danger area for a third time, bringing Schafer's lung back with him. Finally, he led the officer through the contaminated 600-foot tunnel to safety. None of the victims suffered permanent ill-effects from the experience.

ONE OF USAF'S PRINCIPAL HEADACHES—when to change aircraft tires—may have been solved. The B. F. Goodrich Co. is now producing tires with colored under-treads which aid in determining the need for replacement of mounted tires. The colored wear-indicator covers the entire undertread area and is capable of disclosing flat spots and gouges that would not be detected by normal inspection methods. White, red, green and orange dyes are currently being tested for highest proficiency.

REFLECTION OF A JOB WELL DONE. CMSgt. James Wells inspects the wax job on one of the 1502d Air Transport Wing's C-118s based at Hickam AFB, Hawaii. Such coatings are applied approximately every 1,000 hours by the unit's maintenance men such as TSgt. William Carson who awaits Wells' approval. Net results have been higher speeds, less flying time, and reduced gasoline consumption—totaling significant dollar savings and increased efficiency for the Air Force.

Aerospace Library

Space

Alfred J. Zaehringer has authored an historical analysis of Russia's technical evolution in *Soviet Space Technology* (Harper, $3.95). He relates political development to scientific success.

Chilton has released the second volume of Shirley Thomas' *Men of Space* ($3.95). The 10 new profiles include Dr. Walter Domberger, Dr. Hugh L. Dryden, Dr. William Pickering, Dr. Simon Ramo, Dr. W. Randolph Lovelace II, Dr. Edward Teller, Dr. Fred Whipple, Scott Crossfield, Thomas Dixon, and Capt. R. C. Truax.

Space Research by Rocket and Satellite, R. L. F. Boyd (Harper, $2.25) is the latest entry in the Science Today Series and reviews the information gleaned through this research method.

Rockets and Missiles

The Mighty Thor, Julian Hartt (Duell, Sloan and Pearce, $4.50) is a complete documentary of the development and use of this ballistic missile.

Donald B. LeGalley has edited a four-volume series titled *Ballistic Missile and Space Technology.* Released by Academic Press, they sell for $9.00 each, but are priceless as reference works on all technical phases of this basic field.

Willy Ley's *Rockets, Missiles and Space Travel* (Viking, $6.75) has recently been revised and the new edition is currently available.

Fiction

Sabres Over Brandywine, Lt. Col. David McCallister and Lindy Boyes (Hesperian House, $3.95) relates the tale and adventures of an Air National Guard pilot recalled during the Korean conflict.

Donald J. Plantz has chosen a WW II fighter squadron and its young C. O. as the subjects of an exciting novel titled *Sweeney Squadron* (Doubleday, $3.95).

For the Teens

Kent Barstow, Space Man (Duell, Sloan and Pearce, $3.00) is the latest in Rutherford Montgomery's series for younger readers of USAF-based fiction.

Random House has released another in its Landmark series entitled *Great Fighter Pilots of World War II,* Robert D. Loomis ($1.95).

Charles I. Coombs has authored *Bush Flying in Alaska* (Morrow, $2.95), one of the publisher's Junior Books. A colorful account of flying in the Arctic.

You Ask It

In answer to numerous requests, here is a rundown of new manuals and regulations and recent changes thereto of widest Air Force interest.

Manuals

AFM 35-7B, 28 August 1961, *Service Retirements.* Contains major changes, particularly in Chapters 7 and 9.

AFM 35-10A, 1 September 1961, *Service and Dress Uniforms for Air Force Personnel.* The majority of these changes are contained in Chapters 2 and 5.

AFM 35-11Q, 7 August 1961, *Military Personnel Assignment Manual.* Some changes in general assignment procedures and authority.

AFM 35-13J, 8 August 1961, *Flying Status, Aeronautical Ratings, Designations and Parachute Jump Status.* Extensive changes in instructions for the conduct of a flying evaluation board.

AFM 36-1F, 21 June 1961, *Officer Classification Manual.* Outlines minor changes in general and special instructions which became effective on 30 September.

AFM 36-10B, 24 July 1961, *Officer Effectiveness and Training Reports.* Minor changes in the preparation of these reports.

AFM 39-9F, 24 July 1961, *Enlistment and Reenlistment in the Regular Air Force.* Minor changes in instructions regarding qualifications of initial enlistees.

Regulations

AFR 35-12A, 6 September 1961, *Military Suggestion Program.* Contains extensive revisions on where and how to submit suggestions.

AFR 35-17, 30 August 1961, *Personnel Data System Control.* Establishes control over development, design and modification of PDS and explains the method of implementing such controls.

AFR 36-34, 30 August 1961, *Temporary Promotion of Warrant Officers to CWO, W-3 and W-4.* Establishes a selection program and implements DOD Instruction 1205.4, 23 June 1959.

AFR 39-8, 16 August 1961, *Airman On-the-Job Training.* Supersedes an earlier regulation and establishes procedures to control, balance and protect USAF enlisted personnel in grade and skill inventory.

AFR 39-9, 4 August 1961, *USAF School Retraining Program.* A complete rewrite which tells how career airmen may volunteer for retraining through formal technical courses into needed specialties.

AFR 39-40, 28 August 1961, *Airman Control Procedures.* Establishes such procedures for EAD airmen who require special attention.

LANGUAGE
Bridge or Barrier?

by DAVE KARTEN, Airman Staff

Knowledge of one or more foreign languages can be helpful to your Air Force career. It's also a passkey to a more enjoyable tour overseas.

MAXIMILIAN DELPHINIUS BERLITZ, who taught Americans how to order ham and eggs in 38 languages from Arabic to Zulu, had a favorite story.

It concerns an American abroad who was ordering his first meal in a Paris restaurant. Since he spoke little French, he studied the menu for a long time. Then, pointing to the first item on the card, he said: *"Garcon,* bring me some of that."

"Monsieur," replied the waiter, "the orchestra is playing it now."

However amusing this may seem, lack of bilingual dexterity among Americans abroad is no laughing matter. In the U. S. Air Force, personnel and their dependents stationed overseas find they are at a distinct disadvantage if they can't speak the language of the host country. A "language barrier" limits contacts to fellow Americans and those natives who speak English; it impedes "people-to-people" communication with the foreign host; and makes it difficult to understand his ways and customs. Sometimes it breeds suspicion, distrust, and xenophobia (dislike of the unlike).

On the other hand, if you are in command of the local tongue you will find contacts warm and friendly, contributing to good relations between the U. S. and its friends abroad. The American who can speak the language will find doors open to him that are closed to others.

To help promote such international understanding the USAF encourages personnel and their dependents to study foreign languages. The off-duty language training program, recently expanded by the Personnel Services Division, Directorate of Military Personnel, Hq USAF is one example of this attitude. The Air Force, in fact, aspires eventually to have every officer proficient in at least one foreign language.

Today more than ever before, the tools necessary for learning a new language are abundantly available. Correspondence courses (USAFI offers 24 languages in its spoken-language series), phonograph recordings, dictionaries, group-instruction classes—all are available at USAF installations.

A comparatively new Air Force program puts phonograph record language courses in most Air Force libraries along with record players and sound-proof booths or earphones. They are being distributed on the basis of five 5-record sets per library in the most popular foreign languages.

You Can Lead Them to Water . . .

Learning a language can be entertaining and stimulating, but it is something the individual must do himself. Mastery of language is a skill that cannot be force-fed. So how do you go about drinking from this pool of knowledge?

Step number one is to recognize and bury the inferiority complex many people have about languages. This done, you'll slay its common fault—the tendency to ridicule foreign words and expressions just because it's easier to laugh at them than to master them.

Step two, of course, is to select a language. This will depend on personal plans and preferences. Most language specialists agree that Spanish is one of the simplest. French, too, is fairly easy and is a useful second tongue. With a knowledge of both French and English, there are few places in the world where you can't carry on a conversation.

"French, Spanish, and German," explains one of the Education Services officers in Hq USAF, "are rather easy to learn; their retention is high, and instructors and teaching material are available at most locations. Russian and Chinese are more difficult, and have low retention. It's also difficult to obtain instruc-

tors and teaching materials for these. Still, the Air Force thinks it important to include them in the program at this time."

Most off-duty language students in the Air Force are expected to concentrate on learning French, Spanish, or German since they are the primary languages offered in secondary schools and colleges throughout the United States.

High School French Spoken Here

Since all but a handful of newly procured Air Force officers in the future are expected to be college graduates, most will have some background in a foreign language. But will they have a conversational knowledge of the language? One Education Services officer recalled his own experience at the end of World War II.

"I studied French four years in high school. When I got to Paris I could conjugate any French verb, but I couldn't order a meal."

Many people, upon learning they are going overseas, attempt to absorb enough language to get by. Asking directions, ordering a meal, and phrases of greeting usually head the list of things to learn.

Useful as such "cram" courses are, however, they are no substitute for real mastery of a new language. A recorded or strictly conversational course should be supplemented by a textbook giving the rules for verb conjugations, agreement of endings, etc. There are also many language books available which give complete self-instruction. These may help round out what a record course or other kind of study offers, but they can seldom do the whole job. A solid foundation is essential for serious study and a good conversational knowledge of a language.

International understanding is built on the bridge of language. Here A2C Metcalfe of Yokoto Air Base enjoys a quiet game of chess with a young Japanese friend.

One excellent plan consists of starting with private lessons if the student can afford them, and switching to class instruction later. Less expensive, though also less concentrated, is a night course at some nearby school, or an on-base college course.

As part of the new USAF program, all overseas commanders are being urged to conduct formal language courses in the language of the host country. Some overseas bases already have such courses available on-base for airmen and their dependents at nominal cost. Others offer language instruction over the Armed Forces Radio Network. The result is

At a MAAG training facility in Spain, SSgt. Dale Kimmel finds that knowledge of the local language is an asset.

On tour of Izmir, Turkey, SSgt. Eugene Bethel absorbs information given by Turkish NCO on the 2,000-year-old statue of Greek goddess Demeter, symbol of fruitfulness.

always better people-to-people relations. Soon after the U. S. Air Force Base at Itazuke, Japan, began broadcasting lessons in simple Japanese over the Air Force radio station, for example, airmen meeting Japanese began greeting them with *"Ohayo gosaimasu"* (Good morning).

This overseas instruction is not altogether altruistic. One purely practical advantage of bilingual dexterity among airmen is that the Air Force frequently relies on a local labor supply to help maintain its overseas installations. Airmen often work closely with indigenous civilians who may or may not have an adequate knowledge of our language. Fluency of communication makes for better understanding; the job gets done better and faster.

There are many other personal advantages in knowing a second language. Benefits to be derived from an overseas tour may well depend on your ability to understand the language of the country. There is also the matter of self-esteem. When an airman walks into an American Express office and finds the lowest clerk on the staff speaks four or five languages with equal ease, his ego can shrink faster than his supply of traveler's checks.

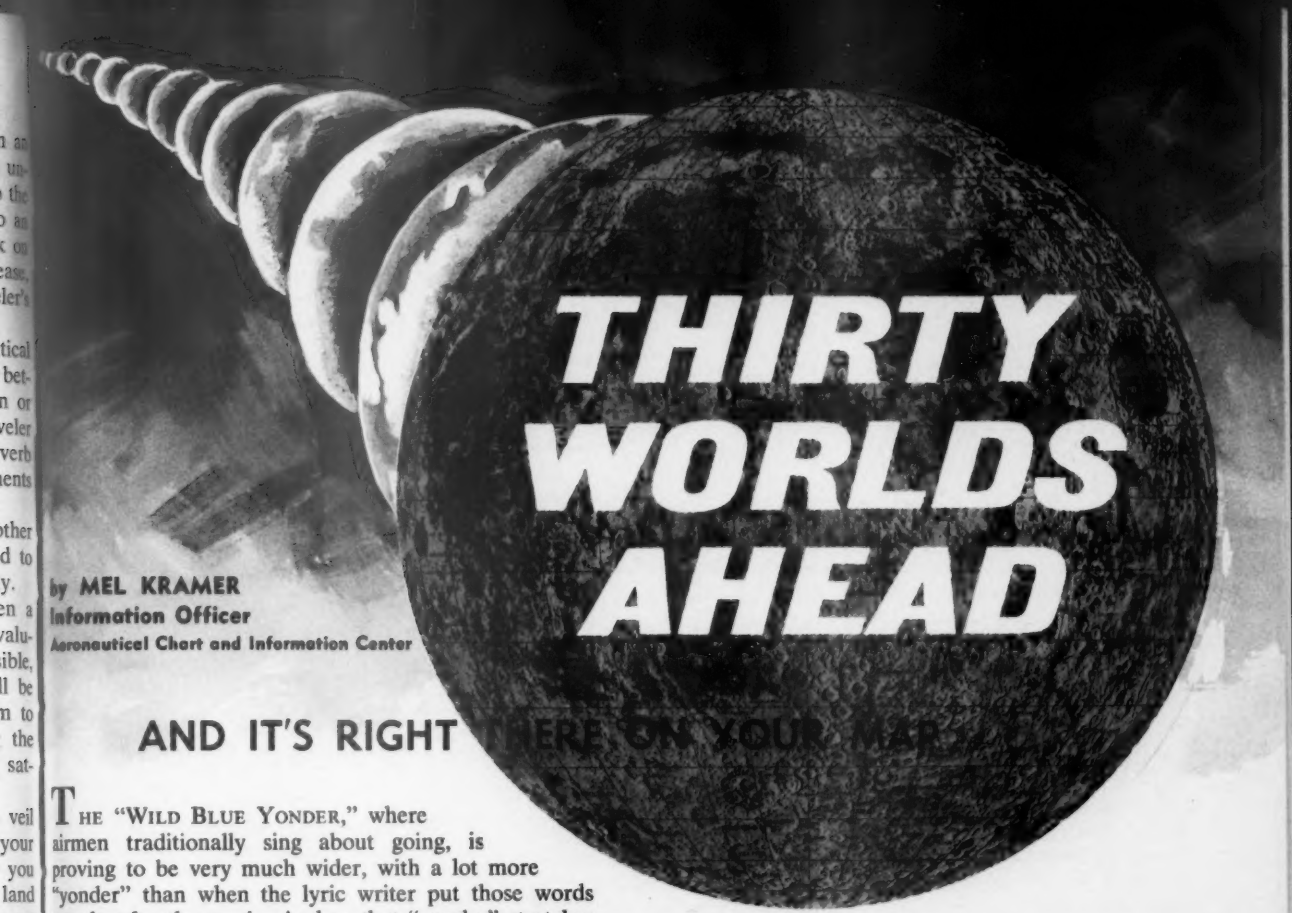
Another point is that learning the grammatical principles of another language will also give you a better insight into your own. Grammar is the pattern or framework on which words are hung. Once the traveler understands why a Spaniard uses a particular verb form in a certain situation, he will discover refinements in his own use of English.

No matter what method you use to learn another language, the important thing is to learn one, and to learn it well enough to speak it and read it fluently.

Few accomplishments can so dramatically open a whole new world. In addition to becoming a more valuable member of the Air Force (whenever possible, under the new program, Air Force personnel will be assigned to overseas areas which will enable them to utilize the language they have studied) learning the language of a foreign country is of immeasurable satisfaction in human terms.

One airman put it this way: "It's like having a veil stripped from your eyes. You find that suddenly your ears are open to the main stream of life about you and that you have ceased to be a stranger in a land far from home. You discover that all at once you are no longer among 'foreigners' but among friends. And that a knowledge of their language can be a passkey to understanding—a key weapon in the cold war."

Teacher at Lindsey Air Station, Germany, introduces a class of Americans to basic usage of German language.



THIRTY WORLDS AHEAD

by **MEL KRAMER**
Information Officer
Aeronautical Chart and Information Center

AND IT'S RIGHT HERE ON YOUR MAP

THE "WILD BLUE YONDER," where airmen traditionally sing about going, is proving to be very much wider, with a lot more "yonder" than when the lyric writer put those words together for the music. And as that "yonder" stretches steadily onward into Space, the USAF Aeronautical Chart and Information Center has been put on notice to provide data for new types of flight patterns, and also to have in readiness reliable maps of the first celestial object an astronaut is likely to reach.

Thus it happened that the name of the Moon was added, not so long ago, to the work list of places for which up-to-date charts were required. As you can learn from astronomy books, it would take almost 30 worlds the size of ours, strung side by side, to bridge the void between the Earth and its natural satellite when they are at average distance. "A far piece," the old saying would describe it.

There was no question, of course, that with the national space program advancing, a need would arise for a series of lunar charts showing the various surface features, their particular characteristics and location coordinates. The assignment for compiling such an atlas of the Moon went, logically enough, to the Chart Center since it has been producing aeronautical charts of the Earth's topography for years. The same range of cartographic detail contained in terrestrial charts will stand a future Moon mission in good stead.

This new assignment, however, involved formidable differences. While photomapping large segments of the Earth's surface may have been "old stuff" to ACIC's cartographers, normally the distance between USAF's airborne cameras and the terrain areas they were covering rarely exceeded several thousand feet or so. To have the charting objective pushed so enormously farther out posed more than a few problems, conservatively speaking, which challenged the experience and ingenuity of the Center's technicians.

The average distance from the Earth to the Moon we see so often in print is usually given as 239,000 miles. This is a round number figure for the more exact measurement of astronomers who give the total as 238,857 miles. For the minimum distance between the two bodies, scientific calculations arrive at 221,463 miles; for the maximum, 252,710 miles.

It took some sophisticated mathematical, optical, and photographic processes to get the project shaped up—but it was done. Lunar charts are now coming off the presses.

Hence, when the first American astronaut and those who follow him arrive on the Moon, they will be equipped with the necessary charts for orientation. And a reliable map on the Moon is far more essential than one for most terrestrial operations. Our satellite is devoid of many of the natural features which serve as checkpoints on Earth; there are no forests, stretches of meadowland, bodies of water, sandy desert areas and so forth. There are mountains, however, although the longest range extends only something over 400 miles.

Because the Moon is approximately only a quarter of the Earth's size, the horizon will always be closer

Built atop a peak in the Pyrenees of southern Francee, Pic du Midi is more than 9,000 feet above sea level.

to the astronaut. Astronomers estimate this distance at perhaps two miles or less. This shortening of the horizon will deny a lunar explorer a chance to take a "fix" on more distant surface features of sizeable elevation because these will be below his line of vision. This sharper curvature of the lunar surface also will make an explorer's portable radio useless after about two miles for contacting a downed lunar vehicle to get reorientation information. Some authorities estimate that even a 100-foot antenna at the lunar vehicle or headquarters base would only boost the effective range to something in the order of 12 miles.

This helps to underscore how much our lunar explorer will depend on his maps for guidance. Although many astronomers have described the Moon's surface as a monotonous wasteland—one writer has likened portions of it to the Badlands of the Dakotas—it does contain numerous topographical features which an astronaut can match against those shown on the ACIC charts to pinpoint where he may land and in what direction any programmed research should take him. These features are depicted as to size on a scale of 1:1,000,000, with shaded relief, contours and tones representing color variations.

Should the landing be in the vicinity of a crater such as Kepler, a 22-mile-wide pockmark in the Northeast Quadrant, the astronaut will be able to establish his position by relating it to the other craters which exist in the vicinity. Kepler, incidentally, happens to be a crater with a ray system — long, broad, light-colored streaks of unknown composition which radiate from the crater walls like the multiple spokes of a wheel. The explorer, studying his chart, could determine, for example, which ray to follow to get to an area specified by his mission. Perhaps it would be informative to note here that science is still uncertain whether the Moon possesses a magnetic pole and, if so, its strength. For this reason, reliance on compasses such as are used on Earth would be foolhardy.

Getting the Job Done

How the Chart Center's technicians conducted this remote survey of a celestial body so many worlds away is almost as fascinating as the first manned mission to the Moon promises to be.

For charting purposes, our atmosphere is no ally of the camera. The densest innermost layer, or troposphere, extends to altitudes of about seven miles and is the soupiest portion. Its air is usually unstable, subject to turbulence, also polluted by dust and other contaminants. In the next layer, the stratosphere, whose arbitrary boundary ends some 22 miles out, conditions improve but handicaps still prevail. At far higher altitudes, as research satellites have ascertained, cosmic dust and other celestial debris have been encountered.

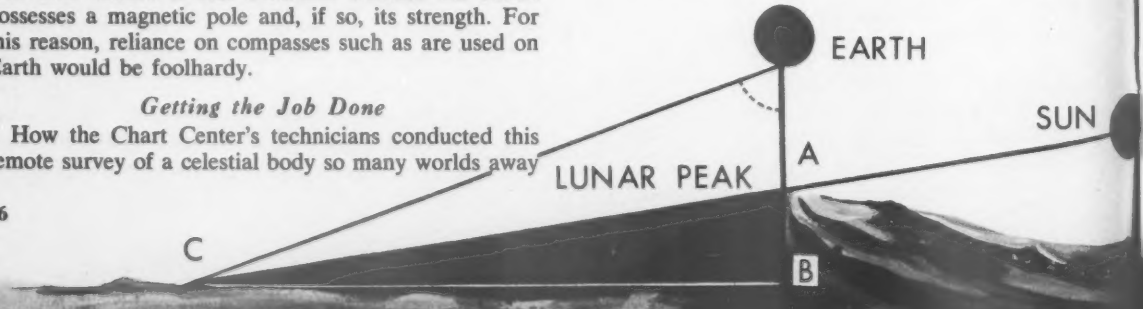
In terrestrial photomapping by high-flying aircraft atmospheric turbulence and dust-fogged air are adverse factors, but making corrective allowances for such interference is rarely a significant problem. The aircraft operates at relatively no great distance above a mapping area, fast photographic techniques are employed and extraneous light sources can be negatived.

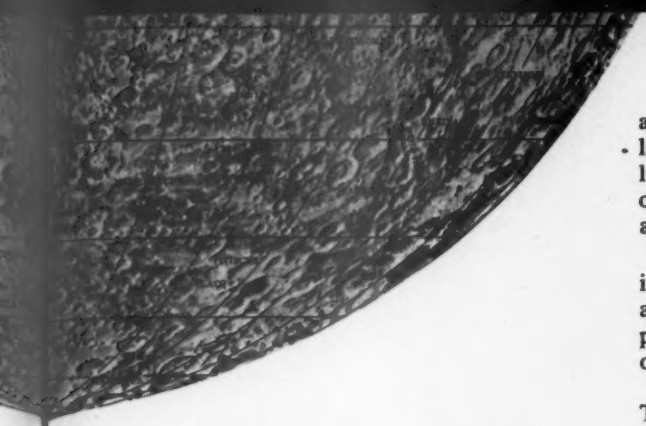
With a lunar photography project, however, the generally erratic behavior of the atmosphere and its changing clarity are major headaches. The intrusion of light from some other source can ruin a plate.

The distances involved, all well over 200,000 miles, add to the exacting nature of the work. The greater the distance, the more exaggerated or distorted a photographic slip-up can become. Air turbulence or contaminants may make for small random variations in scale across the Moon's image.

To bypass the villainy of the densest part of the troposphere, arrangements were made for obtaining photographs of the Moon taken at Pic du Midi, the loftiest observatory in the world. Built atop a peak in the Pyrenees in southern France, Pic du Midi is located slightly over 9,400 feet above sea level and far removed from any city whose illumination might interfere with its telescopes. The air above high mountains

Determination of lunar elevations





is normally what astronomers describe as "still," and still air makes for "good seeing" by telescope.

Measuring elevations and identifying characteristics of other features some 30 worlds away is not easy.

This problem was solved for USAF by a shadow-measuring technique developed at the University of Manchester, England. Although the system dates back to the 19th century, it was refined, and up-dated by a small group of students directed by Dr. Zdenek Kopal of the University's Astronomy Department, under contract with the Air Force Cambridge Research Center.

Knowing the positions of the Sun, Moon, and Earth, geometry is applied and by measuring the length of the shadows cast by sunlight, elevations and depressions on the Moon's surface are determined.

Dr. Kopal obtained photos for this work by setting up a 35 mm. modified movie camera taking three exposures a minute of specific areas on the Moon. The time lapse photos show the changing shape of the shadow as it is cast on the Moon's surface.

Over a two-year period they made about 12,000 individual photos of selected regions. In 1960, their reports, together with this original photography, were turned over to ACIC. They were supplemented by other photographs from Lick and Mount Wilson Observatories in California, the MacDonald Observatory in Texas, and the Yerkes Observatory in Wisconsin.

New Ideas

After many geometric calculations, cartographers at the Center have given us a new idea about the topography of the Moon. Contrary to our concept of craggy cliffs and abrupt craters, most of the Moon's complexion is relatively smooth, with gently sloping hills and ridges.

An instrument called the Variable Perspective Projector helped "crack another nut" in the project. Considerable distortion results from photographing a spherical object on flat film. These distorted images require rectification to bring them into proper relationship. The Moon job was done by projecting negative pictures of the Moon into a curved mirror, thus converting the light rays, which normally narrow down to a pin point, into parallel light rays. The image was reflected on a sphere and rephotographed.

Another problem was posed by the phenomenon called libration, or the oscillatory motion of the Moon as it courses through its orbit. Because of these oscillations—both real and imaginary—18 percent of the lunar surface is alternately visible and invisible to Earth observatories, while 41 percent remains always visible and the other 41 percent is never visible.

Because the Moon's axis is tilted from the plane of its orbit, 6.5 degrees beyond one pole is visible for about two weeks, then the same extent beyond the other pole in the next two weeks. This is libration of latitude, or optically an up-and-down effect.

Then there is a side-to-side or longitudinal libration. This is due to the fact that, while the Moon like our planet rotates on its axis at a regular rate, the velocity with which it revolves about the Earth is not uniform. Its path is an ellipse and its speed is greater at perigee, the closest approach, than at apogee when it is most distant. At perigee, observers can see a little more of the Moon around one side and at apogee, a little more beyond the other side of the always visible lunar disc.

A third variety is the diurnal (or daily) libration which enables an observer to look slightly "over the top" of the Moon when it rises and later a bit "under the bottom" as our satellite is setting. Actually, this becomes possible because of the libration of the observer's Earth platform and not of the Moon.

Finally, there is the libration caused by what is known as precession— a wobbling of the Moon due to a gradual shift of the tilt of its axis with respect to checkpoint stars. This may be compared to the motion of a top which is not spinning perfectly upright but "leans" from the perpendicular, or a gyroscope similarly tipped. If the axis of rotation is related to something fixed, it traces a circle.

The Moon is also subject to an interplay of gravitational forces originating from Solar System components other than the Earth. These cause an alternate acceleration and braking of the orbital motion our satellite would normally have without such interference. The resultant irregularities are known as perturbations. Some produce an extremely slow and steady change in the orbital pattern of the affected celestial body, others cause relatively short intervals of oscillation. Lunar cartographers can find no joy in the fact that the Moon represents one of the toughest perturbation problems known. Tables have been worked out for predicting most of the irregularities it is subject to and these tables fill only three quarto (9.5 x 12 inch) volumes totaling more than 360 pages.

In the whole Moon-mapping project, ACIC's main objective was to get the most out of available lunar information. The production of these charts meets the first challenge in phototopography. As our nation's space vehicle operations require more and more detailed charts and aerospace navigation information, the challenge will increase. Coping with challenges has provided ACIC with the experience that made this Moon-mapping project possible. More challenges will lead to more experience, consequently, wherever man plans to go, ACIC chart makers are confident that they can, cartographically, precede him.

by SMSgt. HAL BAMFORD

Twenty Years Ago This Month

IT WAS A QUIET Sunday morning in Hawaii, but not completely devoid of activity.

About 6:30, a small, unidentified submarine was sighted in a restricted zone off Pearl Harbor. Twenty minutes later, the intruder had been sunk by the destroyer *Ward* and the action reported to the watch officer at the Naval base.

Only minutes later, the radar station at Opana, in northern Oahu, noted a group of aircraft approximately 130 miles northeast of Kahuku Point. The operators duly reported their plot.

In both instances, the "warnings" went unheeded. Less than an hour later, Hawaii was under attack by nearly 200 hostile Japanese aircraft, and the United States was in World War II.

The initial wave of Japanese aircraft included 50 fighters, 50 horizontal bombers, 50 dive bombers, and 40 torpedo bombers. At 7:55 they struck, simultaneously, at Pearl Harbor and Hickam.

For approximately 30 minutes, they rained blows on American installations near Honolulu. Forty-five minutes later, a second wave renewed the attack. This assault included 80 dive bombers, 50 horizontal bombers, and 40 covering fighters.

In its entirety, the attack lasted about an hour. At its end, America reeled from the blow.

The primary purpose of the attack was to cripple the fleet, and the results were monstrous.

Three battleships were sunk; another capsized; a fifth was severely damaged; three others suffered less major wounds.

Three cruisers, three destroyers, and a seaplane tender received damages of varying degrees. A mine layer and a target ship had been sunk.

Naval air installations were severely crippled. Of approximately 170 naval aircraft in the Oahu area, more than half were destroyed.

Three Air Force installations—Hickam, Wheeler, and Bellows—were also badly damaged. Of the 231 aircraft assigned to the Hawaiian Air Force, 64 were destroyed and no more than 79 of the balance were usable for combat.

Despite all handicaps, four P-40s and two P-36s took off from Wheeler within 35 minutes after the initial Japanese assault. Elsewhere, particularly from a small field near Haleiwa, other fighters managed to rise to counter the Japanese thrust.

However, their success was minor. All told, the attackers lost less than 30 aircraft to all causes, including landing losses, in completing their devastation.

By 9:30, Air Force aircraft began a fruitless search for the enemy. Between that hour and 3:30 in the afternoon, nearly 50 sorties were flown in search of the Japanese carriers—all without result.

Meanwhile, officials began counting USAF losses and planning future operations. In addition to the few Hawaii-based aircraft which remained undamaged, they could now count eight newly arrived B-17s in their arsenal.

These latter arrived over Oahu in the midst of the attack. Of 14 which left Hamilton AFB, Calif., the previous evening, 12 arrived at the mid-Pacific island. One had been destroyed during the attack; three were damaged.

Their destination had been the Philippines. They were held temporarily at Hawaii.

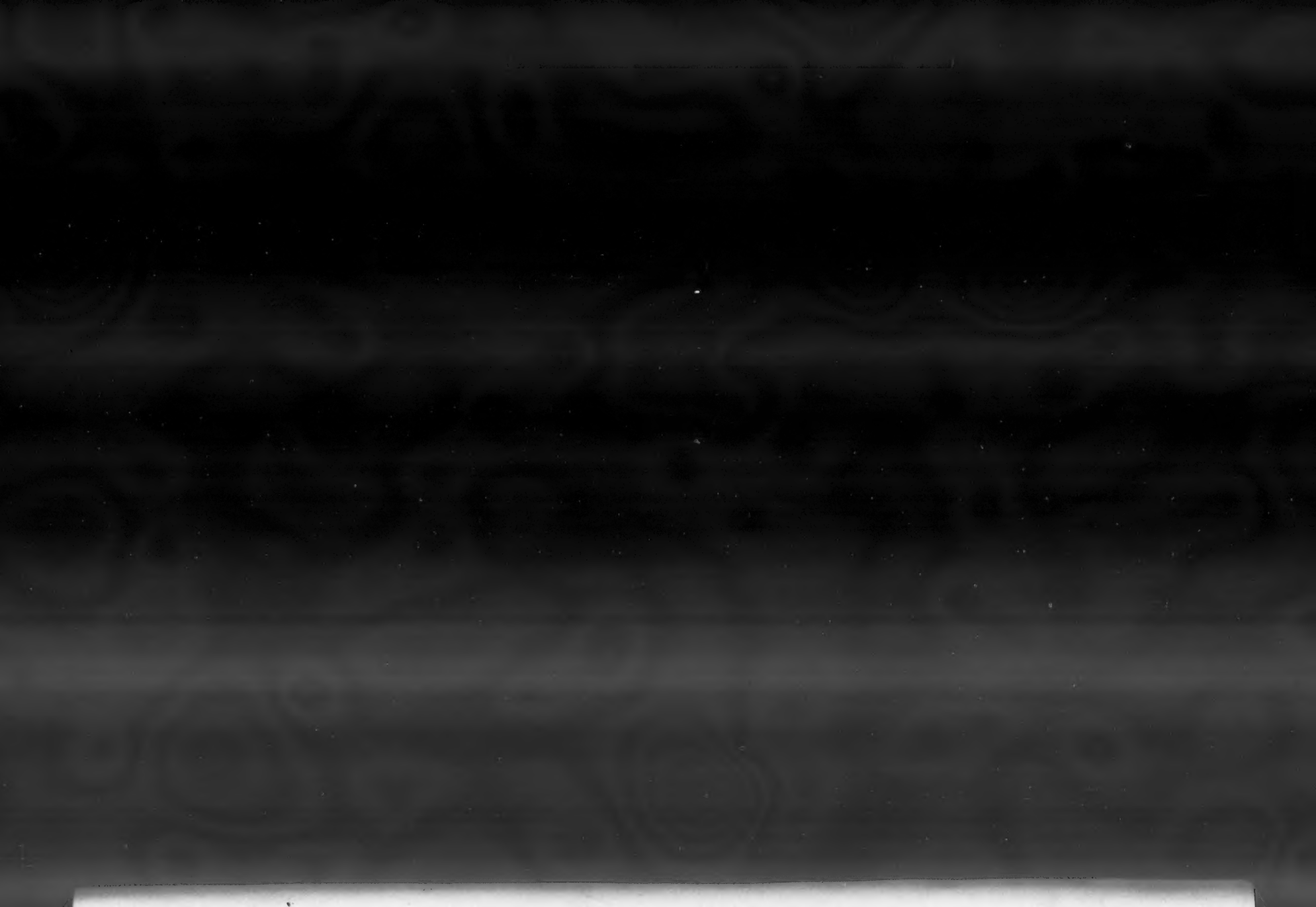
Later the same morning, although it was December 8 in the Philippines, American installations on Luzon were also shattered by a second Japanese blow.

Here, however, unlike Hawaii, the days that followed brought even heavier and more concentrated attacks. In a period of days, air units there were forced to begin a retreat to Australia.

Initial attacks had come from the air, a factor that was prophetic of what was to follow. Before the final victory—then years in the future—airpower was destined to reach maturity and win recognition as a decisive factor in modern warfare.

"Yesterday, December 7, 1941 — a date . . . which will live in infamy"

Black smoke billows up from Hickam AFB, Hawaii, on the morning of December 7, 1941, after the initial Japanese attack which triggered our entry into WW II.

Glory to God
in the highest,
and on earth peace,
good will toward men.

St. Luke 2:14.